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DEPARTMENT OF MINES AND AGRICULTURE.

MEMOIRS OF THE GEOLOGICAL SURVEY OF NEW SOUTH WALES.

E. F. PITTMAN, A.R.S.M., UNDER SECRETARY AND GOVERNMENT GEOLOGIST.

PALÆONTOLOGY, No. 13.

A MONOGRAPH

OF THE

SILURIAN AND DEVONIAN CORALS OF NEW SOUTH WALES;

WITH

ILLUSTRATIONS FROM OTHER PARTS OF AUSTRALIA.

PART I.—THE GENUS HALYSITES.

BY

R. ETHERIDGE, JUNR., J.P.,
CURATOR OF THE AUSTRALIAN MUSEUM, SYDNEY.

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Letter of Transmittal.

Geological Survey Branch,
Department of Mines and Agriculture,
29th November, 1904.

Sir,

I have the honour to submit for publication Part I of Monograph No. 13 (Palæontology Series) on the *Silurian and Devonian Corals of New South Wales*, by Mr. Robert Etheridge, Junior, Curator of the Australian Museum.

Hitherto great difficulty has been experienced in our attempts to establish a dividing line between the Upper Silurian and Devonian rocks of New South Wales, so much so that it has been found necessary to make use of the term *Siluro-Devonian* to describe those rocks near the junction between the two formations, and which were regarded by the late Mr. C. S. Wilkinson, Geological Surveyor-in-Charge, as *Passage beds*.

Obviously the first thing to do in order to clear up this difficult question is to have as complete a description as possible of the fossil forms occurring in the Silurian and in the Devonian formations respectively. The information thus made available will, it is hoped, enable the dividing line to be definitely fixed without much difficulty. The present volume, dealing with the genus *Halysites*, may be regarded as the first portion of this important work which has been undertaken by Mr. Etheridge.

I have the honour to be,
Sir,
Your obedient servant,
EDWARD F. PITTMAN,
Government Geologist.

The Honourable the Minister
for Mines and Agriculture.

Author's Preface.

With the approval of the Under Secretary for Mines and Agriculture, and the concurrence of the Trustees of the Australian Museum, the Author has undertaken the preparation of a "Monograph of the Silurian and Devonian Corals of New South Wales," chiefly based on specimens contained in the Mining and Geological and Australian Museums in Sydney. To render the work more complete descriptions and illustrations of similar Corals from other parts of Australia will be introduced when practicable.

In consequence of the pressure of other official duties it was found impossible to prepare a Memoir of this description *in extenso*, as a complete work. After deliberation it was determined to publish it in parts, each part to contain the species of one genus at a time, but the genera not necessarily following one another in systematic order. The sequence of the latter will be principally determined by the completeness of the material to hand.

The first, and present part, will contain the species of the Genus *Halysites*. In connection therewith, the Author desires to place on record his indebtedness to the Rev. J. M. Curran, late of the Technical College, and Mr. C. A. Süssmilch, of the same Institution, for the loan of material; to Mr. W. S. Dun, Palæontologist to the Geological Survey of New South Wales, for cordial assistance; to Mr. E. F. Pittman, for the official publication of the work; and to the Trustees of the Australian Museum for permission to use the collection in their charge.

I.—INTRODUCTION.

Two species of *Halysites* are at present known from Australasian Silurian rocks and none from the Devonian. *Halysites australis* is met with at Molong, N. S. Wales, and the other described, although at present unnamed species, comes from the Gordon River Limestone in Tasmania. Through the efforts of the Rev. J. M. Curran and Mr. C. A. Süssmilch on the one part, and Mr. C. Cullen, Collector to the Geological Survey of N. S. Wales, on the other part, a very fine series of specimens has been brought together from the Molong and Canobolas Districts.

Many of these are of large size and very beautifully preserved, being weathered quite clear of matrix. They exhibit the essential anatomical characters quite as well in this condition as in sections prepared for the microscope; upwards of one hundred specimens have in all been examined.

The specific determination of these corals has been rendered most perplexing and difficult in consequence of the widely divergent views held by authors on the relative value of specific characters in *Halysites*, and, in consequence, the chaotic state of the names applied to the various forms. Reference to old-world species is rendered still more difficult by the absence from descriptions, except on the part of a few writers, such as Fischer-Benzon, Nicholson, Lambe, &c., of all allusion to microscopic characters, other than in the most general terms.

After working at the subject for some weeks, I felt that any hard-and-fast references to European or American species, in our present knowledge of these, would be so hopeless, that it became necessary to adopt some other method for the elucidation of the Australian corals. I accordingly endeavoured to arrange the latter, in the first instance in lots, simply on their macroscopic features, and, notwithstanding the contrary opinion held in other parts of the world of the difficulty in so separating species of *Halysites*, I succeeded in grouping the specimens beyond my anticipations. That is to say, the external characters of our corals are sufficiently well marked to render possible the separation of a large parcel into groups of specimens possessing certain features in common that were afterwards found to exhibit similar microscopic details, which appeared to me to be of specific value.

II.—HISTORY OF THE DISCOVERY OF HALYSITES IN AUSTRALASIA.

I HAVE already stated[1] that the late Prof. L. G. de Koninck was the first to record[2] the occurrence of this genus in N. S. Wales. This statement is accurate only in so far as description is concerned, for the late Prof. A. M. Thomson, who, in 1869, accompanied the late Mr. Gerard Krefft to the Wellington Caves, and geologically examined that district, was the first to identify *Halysites* as a N. S. Wales fossil.[3] Subsequent to De Koninck's description, the late Mr. C. S. Wilkinson reported the presence of *Halysites* in beds of marble limestone, ten miles west of Forbes. He remarked,[4] "The presence of this latter genus proves the Upper Silurian age of these beds." The next in order of discovery was apparently the Rev. J. M. Curran, who collected many specimens near Molong, as already recorded by me; Wilkinson placed the Molong Limestones as the "uppermost or 'passage beds'" of the Upper Silurian.[5] In 1898, Mr. Curran's Molong coral was described by me as *Halysites australis;*[6] and in 1900, a note on the Tasmanian form was published.[7] A still more interesting discovery of this coral was made in 1901, at Chillagoe, Queensland, by Mr. B. Dunstan,[8] which opens up a highly important geological question in that State.

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[1] Etheridge, Austr. Mus. Rec., III, Pt. 4, 1898, p. 78.

[2] De Koninck, Foss. Pal. Nouv. Galles du Sud, Pt. 1, 1876, p. 16; or, perhaps more correctly, Mém. Soc. R. Liége, II (2), 1876.

[3] Thomson, N. S. Wales Votes and Proc., IV, 1870–71, p. 1183; Explor. Caves and Rivers N. S. Wales, 1882, pp. 4 and 12. It is possible that a discovery by the late Rev. W. B. Clarke was anterior to this. He said, "Since 1858 . . . I have detected Halysites." (Remarks Sed. Formations N. S. Wales, 4th edit., 1878, pp. 13 and 129.)

[4] Wilkinson, Ann. Rept. Dept. Mines N. S. Wales for 1878 (1879), p. 151.

[5] Wilkinson, Ann. Rept. Dept. Mines N. S. Wales for 1885 (1886), p. 127; *Ibid.* for 1886 (1887), p 133.

[6] Etheridge, Austr. Mus. Rec., III, Pt. 4, 1898, p. 78, pl. xvii.

[7] Etheridge, Proc. R. Soc. Tas. for 1898–99 (1900), pp. xxviii and 81.

[8] Dunstan, Ann. Rept. Dept. Mines Q'land (Q'land Parl. Papers, C. A. 18, 1901), 1901, p. 197; Report Geol. Survey Q'land, No. 159, 1901, p. 21.

III.—DIFFICULTIES MET WITH IN AN ATTEMPT TO IDENTIFY EUROPEAN AND AMERICAN SPECIES OF HALYSITES.

Many species have been described from time to time, but from the variability that appears to exist in the macroscopic characters—such as size of the corallites and fenestrules,[1] length of the corallite chains,[2] and supposed presence or absence of spiniform septa, &c., and possibly from the absence of microscopic details—the species, both European and American, were reduced by Messrs. H. Milne-Edwards and Jules Haime to two, viz., *Halysites catenularius*, Linn., and *H. escharoides*, Lamk. The two corals in question were separated by these authors, chiefly on the grounds that the corallites differed in size, but both were said to possess twelve spiniform septa in a cycle.

An effort to establish the identity of our Australasian *Halysites* has caused me to peruse a good deal of the literature relating to the genus, and I have been forced to the conclusion that an entire revision of the described species is necessary. This is, of course, out of the question on my part; but I have selected some of the more important writers, both old and recent, whose remarks are referred to with the view of testing the validity of Edwards and Haime's subdivision and synonomy. I have further endeavoured to reduce my notes to tabular form, restricting the characters to those only possessing the highest morphological value. I cannot help coming to the conclusion that a great deal of confusion has arisen through mis-identification —the *H. catenularius* of one author being the *H. escharoides* of another, and so on.

1826.—Goldfuss (A.).[3]—Described and figured two species, *Catenipora escharoides*, Lamk.[4] (with which he united *C. catenulata*,[5] Linn.), and *C. labyrinthica*, Goldf.[6] The only anatomical detail to be made out is the presence of autopores.[7]

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[1] The vacuities or interspaces formed by the union of the lines of corallites; the lacunæ or "irregular reticulations" of Edwards and Haime.

[2] The lines of corallites forming the boundaries of a fenestrule.

[3] Goldfuss, Petrefacta Germaniæ, 1826, pl. xxv, f. 4-5b.

[4] *Halysites escharoides*, Edw. and Haime, 1852 and 1854.

[5] This name will be invariably spelt as by the author quoted.

[6] *Halysites catenularia*, Edw. and Haime, 1852 and 1854.

[7] The largest corallites in a chain.

1830-37.—Fischer de Waldheim (G.).[1]—Described and figured *Halysites escharoides*, Lamk. (with which he also united *H. catenulata*, Linn.), and *H. labyrinthica*, Goldf.[2] Autopores only are again shown.

1834.—Blainville (H. M. de).[3]—In *Catenipora escharoides*, Lamk. described the presence of septa ("lames rayonnantes"), and again united with it *H. catenulata*, Linn.

1839.—Lonsdale (W.).[4]—United *Catenipora escharoides*, Lamk., *C. catenulata*, Linn., and *C. labyrinthica*, Goldf., in one species,[5] using the first of the three names.

1845.—Lonsdale (W.).[6]—Described only *H. labyrinthica*, and said "incipient lamellæ being clearly 12."

1851.—McCoy (F.).[7]—Described *H. catenulatus*, Linn., and united with it *H. escharoides*, Lamk., and *H. labyrinthica*, Goldf. The expression "the small openings of the young tubes [mesopores] most frequently seen at the points of anastomosing" [gonopores], would seem to indicate that McCoy considered specimens representing the foregoing combination of names, expressed under that of the one species,[8] to possess both mesopores[9] and gonopores,[10] without grasping their true meaning. Prof. McCoy further stated that *Halysites* possessed from fourteen to sixteen septa, "internal vertical sulci (rudimentary lamellæ)," and "funnel-shaped diaphragms" [tabulæ].

1852.—Hall (J.).[11]—Described an American form as *Catenipora escharoides*, Lamk.,[12] and a new species *C. agglomerata*. Under the first he referred to the corallites being "in a single series, or separated by a cellular interspace," and again, "septate transversely and striated longitudinally," *i.e.*, possessing both tabulæ and septa. In *C. agglomerata*[13] he noticed the

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[1] Fischer de Waldheim, Oryct. Gouv. Moscou, Pt. 3, 1830-37, p. 163.

[2] *Halysites catenularia*, Edw. and Haime 1852 and 1854.

[3] Blainville, Man. d'Actinologie, 1834, p. 353

[4] Lonsdale, Murchison's Sil. Syst., 1839, p. 685.

[5] *Halysites catenularia*, Edw. and Haime, 1852 and 1854.

[6] Lonsdale, Murchison's Geol. Russia in Europe, 1845, p. 593.

[7] McCoy, Brit. Pal. Foss., Fas. 1, 1851, p. 26.

[8] *Halysites catenularia* (pars), Edw. and H., 1854.

[9] The smallest corallites in a chain.

[10] The corallites of intermediate size at the fenestrule angles.

[11] Hall, Pal. N. York, II, 1852, p. 127.

[12] *Halysites catenularia*, Edw. and H., 1854.

[13] *Halysites catenularia?* Edw. and H., 1854.

mesopores as "spaces between the tubes [autopores] cellular," and the septa numerous, together with tabulæ.[1] Hall appears, therefore, to have been the first, as Nicholson remarked,[2] to *figure* more than one set of corallites in *Halysites*.

1852.—Milne-Edwards (H.) and Haime (J.).[3]—These authors restricted all the then known forms of the genus to two species as already explained. *H. catenularia*, Edw. and H., comprised those corals with large fenestrules, and from three to eight corallites in a chain, and *H. escharoides*, Edw. and H., those with small fenestrules, and two to three tubes in a chain; twelve spiniform septa in both species.

1854.—Milne-Edwards (H.) and Haime (J.).[4]—The same restriction was maintained in the second work by these authors.

1852-54.—Roemer (F.).[5]—As *Halysites catenularia* this author figured a largely fenestrate coral after the type of *H. labyrinthica*, Goldf., with all three forms of corallites, and twelve septal spines.

1860.—Eichwald (E. d').[6]—Described both *H. catenularia*, Linn., uniting with it *H. labyrinthica*, Goldf., and *H. escharoides*, Lamk. In the former there are from three to eight corallites in a chain, with twelve septa, and in the latter eight to ten in a chain, thus increasing the number of serial corallites mentioned by Edwards and Haime. No special reference to the existence of septa is made under *H. escharoides*, but from the fact that the number twelve is mentioned in the generic description, it must be assumed that Eichwald intended this number to apply to Lamarck's species also. He further describes five other species of his own, which Milne-Edwards and Haime distributed between the two type species as synonyms. No reference is made to more than one form of corallite.

1865-66.—Ludwig (R.).[7]—Under the unfortunate generic name of *Ptychophloeolopas!* described and figured *H. catenularia*, Edw. and H. Two

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[1] Hall, Pal. N. York, II, 1852, p. 129, pl. xxxv *bis*.

[2] Nicholson, Tab. Corals Pal. Period, 1879, p. 228, foot-note.

[3] Milne-Edwards and Haime, Polyp. Foss. Terr. Pal., 1852, pp. 283 and 285.

[4] Milne-Edwards and Haime, Mon. Brit. Foss. Corals, Pt. 5, 1854, pp. 271 and 273.

[5] Roemer, Bronn's Lethæa Geog., 3rd Aufl., I., 2 Th., 1852-54, p. 182, pl. v. 8

[6] Eichwald, Lethæa Rossica, I, Pt. 2, 1860, pp. 505-508.

[7] Ludwig, Palaeontographica, xiv, 1865-66, p. 236, pl. lxx, f. 3*a-c*.

calices are very distinctly represented side by side in the same chain, and following one of them a mesopore, also a corallite with rolling tabulæ, or as Ludwig described them "bow-shaped." Twelve septa are represented.

1871.—Fischer-Benzon (R.).[1]—This author's paper was the first real attempt to portray the more minute and detailed structure of *Halysites*. After a long study of a very carefully prepared translation, I have come to the conclusion that from a systematic point of view too much importance cannot be attached to it, and as an exposition of the microscopic structure it stands before any other writing I have access to. Dr. Fischer-Benzon's material appears to have been derived chiefly from diluvial boulders exhibiting little, if any, of the more important external features of the corallums, and from this cause it is, and will remain difficult, to assign his species to already known forms, even if it be found necessary to do so.

In his generic description the author referred to—(1) the free chains;[2] (2) the wrinkled epitheca; (3) twelve or more delicate spiniform septa; (4) the distal ends of the latter sometimes blended into a spurious columella: (5) complete and incomplete tabulæ of the autopores; (6) tabulate nature of the mesopores (thus supporting Hall's description of his *Catenipora agglomerata*) possessing a dual structure—(*a*) saddle-shaped and lenticular vesicles, or (*b*) horizontal tabulæ, enclosing small regular visceral chambers; (7) complicated structure of the intermediate or mesoporal walls; and (8) lateral gemmation.

Fischer-Benzon adopted a classification of his species based on the structure of the mesopores and their walls; and remarked, "as nearly all the earlier figures of *Halysites* are without accurate delineations of the dividing walls [of the corallites], and the peculiar calices are not enlarged, it is difficult to distinguish them from one another, specially so if one has no opportunity of investigating the original specimens." This is perfectly true; but the structural details employed by Fischer-Benzon appear to depend so much on the degrees of development and secondary alteration, that I am afraid his method of classification will not stand the test of future research.

Fischer-Benzon regards the structure of the mesoporal walls, or those separating the mesopores from the autopores, as of great importance. He says, "The nature of these dividing walls seems to me the most certain means

[1] Fischer-Benzon, Abhandl. Gebiete Naturwis. Verein Hamburg, V, 2 Abth., 1871, p. 31 (separate copy), pls. iii.

[2] New chains with a free end projecting into a fenestrule.

of distinguishing individual species from one another, or at least of dividing them into definite groups. The size or even the shape of the individual calices is much less important." And again, "The nature and construction of the dividing walls can supply a means of separating the species of *Halysites* into several groups." According either to his descriptions or figures, the corallites (autopores) are separated (*a*) by two pairs of vertical bars, or "rods," arising from the main chain walls and meeting in the centre, each pair, with the assistance of the latter, thus enclose between them one of Nicholson's "interstitial tubuli," or, as I here term them, mesopores;[1] (*b*) at times these "rods" blend into a single partition at each end of an autopore;[2] (*c*) the longest diameter of these rods may be either parallel to or at right angles to the direction of a chain of corallites;[3] (*d*) after blending, the walls may be so thickened as to all but obliterate the visceral chambers of the mesopores;[4] (*e*) the blending may proceed to such an extent as to ultimately obliterate the intermediate chamber, or mesopore.[5]

The principal points brought out in the specific descriptions are the following:—*Halysites cavernosa*, F.-B., possesses both complete and incomplete tabulæ in the autopores, and there are no spiniform septa; the mesopores are highly vesicular. In *H. regularis*, F.-B., the tabulæ of the autopores and mesopores are practically complete and normal; but the structure of the "rod" walls of the latter is peculiar, and if constant, characteristic of the species. In his conception of *H. labyrinthica*, Goldf., the tabulæ of the autopores are at times very incomplete and highly vesicular, the vesicles large, but those of the mesopores are normal. *H. obliqua* is a septate form, with the peculiarity that certain of the septa proceed from the transverse dividing walls between the autopores; there is no clear evidence of the presence of mesopores. *H. approximata*, Eichw., is said to possess numerous complete ("single") tabulæ. In *H. parallela*, F. Schmidt, the tabulæ are concave ("bent down"). Fischer-Benzon's conception of *H. escharoides*, Lamk., presents several points of very great interest. In the first place, the septa are said to blend at their inner or distal ends into a false columella, often so strongly developed as to become exsert; there are five cycles in a visceral chamber. The mesopores are either

[1] Fischer-Benzon, *Op. cit.*, pl. i, f. 2 and 9.
[2] *Ibid.*, *op. cit.*, pl. ii, f. 5; pl. iii, f. 2.
[3] *Ibid.*, *op. cit.*, pl. i, f. 9; pl. ii, f. 2 and
[4] *Ibid.*, *op. cit.*, pl. iii, f. 3.
[5] *Ibid.*, *op. cit.*, pl. iii, f. 2.

very small or entirely obliterated; and in the former case, the "rods" forming their walls are two at each end, meeting and coalescing in the middle; in the latter case, the walls have a solid and homogeneous appearance; the tabulæ are complete. *H. elegans*, F.-B., also possesses a false columella, and the edges of the autopores are strongly festooned by the septa, of which there are two cycles only to each visceral chamber. *H. quadrata*, F.-B., again has a strongly developed false columella, and both mesopores and gonopores are shown in the figure. In the last species described, *H. jacovickii*, F. de Waldheim, the corallum is built with remarkable regularity, and more or less resembles a *Favosites;* mesopores and gonopores are both present, but the spiniform septa do not coalesce at the calicinal centres.

1873.—Lindström (G.).[1]—This author, in describing Swedish Lower Silurian corals, mentions an example of *H. escharoides*, Lamk., from Dalarne, in which the spiniform septa unite at the calicinal centres to form irregular spongy masses, thus confirming Fischer-Benzon's description of his false columella.

1873.—Lindström (G.).[2]—The same writer, in an article on the "Anthozoa Tabulata," described two forms of zooids in *Halysites* as in *Heliolites*. He remarked that between the larger zooids (autopores), with their widely-spaced tabulæ, occurred smaller vesicular tabulate tubes ("cœnenchyma," or our mesopores).

1876.—Rominger (C.).[3]—Dr. Rominger united *H. catenularia*, Linn., *H. escharoides*, Lamk., and *H. labyrinthica*, Goldf. He recognised in a generic sense twelve septa ("longitudinal crests") and "flat diaphragms" (tabulæ), but did not make any reference to corallites of more than one order, although in one figure[4] at least mesopores are shown.

1879.—Nicholson (H. A.).[5]—At the time my deceased friend wrote his masterly work on the "Palæozoic Tabulate Corals," he had not seen Dr. Fischer-Benzon's paper, and he restricted his observations to the two typical Edwardsian species. He distinguished *H. catenularia* by the presence of zooids of two orders and no septal spines, and *H. escharoides* by the possession of corallites of one order only, and these with twelve septal spines

[1] Lindström, Öfvers. K. Vet.-Akad. Forhandl. Stockholm, 1873, No. 4, p. 25.

[2] Lindström, *Loc. cit.*, p. 16.

[3] Rominger, Report Geol. Survey Michigan—Lower Peninsula, 1873-76, III, Pt. 2, 1876, p. 78.

[4] Rominger, *Loc. cit.*, pl. xxix, f. 2.

[5] Nicholson, Tab. Corals Pa Period, 1879, pp. 226-231.

to a cycle. The great value of Nicholson's observations lay in his confirmation of Lindström's previously expressed opinion, that "each colony of the typical *H. catenularia*, Linn., consisted of two structurally and functionally distinct sets of zooids," and in a general way of Fischer-Benzon's researches also. The morphological structure of *Halysites* is fully entered into by Nicholson in his usually clear and lucid style, and his conclusions were briefly as follows:—(*a*) The epitheca and corallite walls are continuous, and the former does not take any part in the formation of the transverse walls; (*b*) the partitions between corallites are formed by their coalesced walls solely; (*c*) corallites are of one or two orders, as the case may be, normal corallites and interstitial tubes; (*d*) when both are present, the tabulæ of the former are complete, and those of the latter sometimes vesicular; (*e*) the normal corallites may or may not be septate; (*f*) the interstitial tubes sometimes appear to possess modified septa; (*g*) the septa are spiniform, arranged in vertical rows, and twelve in a cycle.

1883.—Lindström (G.).[1]—In a Chinese coral referred to *H. catenularius*, Linn., Lindström described twelve short thick septa in the autopores, simple tabulæ, and solid inter-autoporal walls.

1883.—Roemer (F.).[2]—This eminent Palæontologist accepted Fischer-Benzon's views as to the existence of a false columella in some species. He described *H. catenularia*, Linn., with twelve septa extending to near the centre of the corallites, and close and horizontal tabulæ; intermediate tubes (mesopores) sometimes present with similar tabulæ. *H. escharoides*, Lamk., is distinguished only by the less size of its corallites, and a smaller number in a chain.

1890.—Steinmann (G.).[3]—Gives figures and a brief description of *H. catenularia*, Linn. His illustration of the transverse section is copied from Fischer-Benzon's figure of *H. cavernosa*, F.-B., with all its peculiarities. In the longitudinal section complete and incomplete tabulæ are seen in the autopores, and complete in the mesopores.

1894.—Weissermel (W.).[4]—Refers to *H. catenularia*, Linn., as "this easily distinguishable form"! Between every pair of large corallites (autopores) occur one or two small tubes (mesopores), but septa are absent in the

[1] Lindström, Beiträge Pal. China (Richthofen's China, IV), 1883, p. 60.

[2] Roemer, Lethæa Pal., 2 Lief., 1883, p. 486.

[3] Steinmann, Elemente Pal., 1890, p. 109, f. 111.

[4] Weissermel, Zeit. Deutschen Geol. Gesellsch., XLVI, 3 Heft, 1894, p. 661.

former, tabulæ complete, horizontal or curved, but closer in the mesopores than in the autopores. Refers to the presence of septa and absence of mesopores in *H. escharoides*. Subscribes to the dimorphic theory of Nicholson,[1] and supports it by figuring a *H. catenularia*, with mesopores, and with spiniform septa in one of the autopores.

1896.—Sardesson (F. W.).[2]—This author uses the term autopore for the largest corallites in a chain, as here adopted, but Nicholson's interstitial tubuli are termed siphonopores, one between each pair of the former, in *H. catenularia*, Linn. He describes pseudo-septa and close, horizontal, or oblique tabulæ in the autopores, and states that budding takes place chiefly from the chain junctions (gonopores, *mihi*). In *H. escharoides* there are twelve pseudo-septa, meeting at their distal ends, but mesopores are "seldom" developed.

1899.—Lambe (L. M.).[3]—No writer has more forcibly recognised the great difficulties attending the discrimination of species in this genus than Mr. Lambe. He states that the structure of Canadian specimens does not bear out Nicholson's method of distinguishing the species by their internal structure—the presence or absence of both spiniform septa and secondary corallites (mesopores).[4] It must not be forgotten, however, that Nicholson confined his remarks to the two Edwardsian type species.

As *H. catenularius* proper, Mr. Lambe figures a coral with autoporal spiniform septa and mesopores; the tabulæ of the autopores are horizontal or slightly concave, and those of the mesopores close-set, strongly arched, and almost at times vesicular. The last condition shows a remarkably close affinity to Fischer-Benzon's longitudinal section of *H. cavernosa*, F.-B. Var. *quebecensis*, Lambe, differs by possessing narrow mesopores with distant horizontal tabulæ, and in the absence of the spiniform septa of the species in chief. Var. *gracilis*, Hall, is without mesopores, but autoporal septa are present, and the tabulæ are distant, horizontal, concave, or rolling. Var. *simplex*, Lambe, possesses very large autopores, questionable spiniform septa, and no mesopores, the tabulæ are wide apart, horizontal, concave, rolling, or sub-vesicular here and there. Var. *amplitabulata*, Lambe, is a very interesting form in which the mesopores are "as large as and even larger than" the

[1] Nicholson, Tab. Corals Pal. Period, 1879, p. 230.

[2] Sardesson, Neues Jahrb. Min., Beil. Bd. X, 2 Heft, 1896, p. 272.

[3] Lambe, Contrib. Canadian Pal., IV, Pt. 1, 1899, pp. 64–78.

[4] Lambe, *Loc. cit.*, pp. 66 and 67.

autopores, with very close-set "coalescent" or vesicular tabulæ, those of the autopores being "comparatively regular and distant"; this vesicular structure again indicates a departure towards *H. cavernosa*, F.-B.; there are no spiniform septa. Var. *nitida*, Lambe, possesses septa in the autopores and mesopores, with very compact, regular, and horizontal or slightly concave tabulæ in both.

If Mr. Lambe is correct in referring these diverse forms of structure to the typical *H. catenularius*, Linn., as varieties, and I say "if" without the slightest wish to impugn the accuracy of his determinations, then it certainly seals the fate of Nicholson's suggested method of distinguishing between the two supposed type species. For my own part I much prefer to regard Lambe's varieties as separate species.

1902.—Počta (P.).[1]—The observations of this author, one of the most recent writers on *Halysites*, are of importance. His study of the Bohemian corals leads him to conclude that only two species are well-defined—the two typical forms of Milne-Edwards and Haime. He unhesitatingly accepts Nicholson's method of separating them, and states that the spiniform septa vary from twelve to fifteen, but the coral with zooids of two orders (*H. catenularius*, Linn.), rarely possesses them. Mr. Počta is unable to confirm Fischer-Benzon's description of vesicular tabulæ in *Halysites* from personal observation, but he records a new and very important feature in *H. escharoides*, the closing of the autopores by oval, concentrically-striated opercula, probably the uppermost tabulæ, as in some *Favosites*.

[1] Počta, Barrande's Syst. Sil. Bohême, VIII (ii), 1902, pp. 272-275.

Author.	Halysites catenularius, *Linn.*							Halysites escharoides, *Lamk.*						
	Auto-pores.	Autoporal septal spines.	Autoporal tabulæ.	Mesopores.	Mesoporal septal spines.	Mesoporal tabulæ.	Gono-pores.	Auto-pores.	Autoporal septal spines.	Autoporal tabulæ.	Meso-pores.	Meso-poral septal spines.	Meso-poral tabulæ.	Gono-pores.
1826–Goldfuss	Figd. ..	.....	.....	.....	....	.....	....	Figd. ..	.....	....	....	....	....	....
1830-37–Fisher de Waldheim.	,, ..	.....	.....	.....	....	.....	....	....	.....	....	....	....	....	....
1834—Blainville	.....	.....	.....	.....	....	.....	....	....	Described..	....	....	....	....	....
1839—Lonsdale	Figd. ..	.....	.....	.....	....	.....	....	. ..	.....	....	....	....	....	....
1851—McCoy[1]	Described	14-16	Funnel-shaped	Inferred ..	....	.....	Inferred..	....	.....	....	....	....	....	....
1852—Hall.....	Desc. and figd.	Described..	Described.....	Described..	....	.....	....	Desc. and figd.[6]	Described..	Hor. or oblique.	Present or absent.	....	....	....
1852—Milne-Edwards and Haime.[2]	Described	12, to centre	Hor. and close	.....	....	.....	....	Deserbd.[7]	12	Close	....	....	....	....
1854—Milne-Edwards and Haime.	,,	,,	,, ...	.....	....	.....	....	,,	12	,,	....	....	....	....
1852-54—F. Roemer ..	Figd. ..	12	.....	Figd.....	....	.....	Figd.	....	.....	....	....	....	....	....
1860—Eichwald[3]	Described	12, to centre	.....	.....	....	.....	....	....	.....	....	....	....	....	....
1865-66—Ludwig	Figd. ..	12	Rolling.....	Figd.....	....	.....	....	....	.....	....	....	....	....	....
1871—Fischer-Benzon..	.....	.....	.....	.....	....	.....	....	Desc. and figd.	12, blending into a false columella.	Hor. or rolling.	Small or obliterated.	....	Hor. ..	Figd
1873—Lindström	.....	.....	.....	.....	....	.....	....	....	12, blending into a false columella.	....	....	....	....	....
1876—Rominger[4].....	Figd. ..	12	Flat	Figd.....	....	.....	....	....	.....	....	....	....	....	....
1879—Nicholson	Desc. and figd.	.....	Remote, oblique, rolling, or vesicular.	,, ...	Figd....	Close, hor., or subvesicular.	Figd. ..	Desc. and figd.	12	....	....	....	....	....
1883—Lindström	Described	12	Complete	.....	....	.....	....	....	.....	....	....	....	....	....
1883—F. oemer	,,	12, to centre	Close and hor.	Sometimes present.	....	Close and hor.	....	....	.....	....	....	....	....	....
1890–Steinmann	Figd. ..	.....	Distant, curved, or vesicular.	Double or treble.	....	,,	....	....	.....	....	....	....	....	....
1894—Weissermel.....	,, ...	Occasionally present.	Hor. or curved	Single or double.	....	Close, and hor.	....	Described	12	....	....	....	....	....
1896—Sardesson	Described	Described..	Close, hor., or oblique	Small	...	Close	....	,,	12, blending at centre.	....	Seldom present.	....	....	....
1899—Lambe[5]	Desc. and figd.	12, or absent	Close or distant; hor., concave, and rolling or subvesicular.	Present or absent.	....	Close, arched. hor., or vesicular.	....	....	.....	....	....	....	....	....
1902—Počta	Desc. and figd.	Rarely present.	Hor. or concave, opereula.	Figd.....	....	Close, hor., or concave.	Figd. ..	Described	12-15	....	....	....	....	....

[1] McCoy included *H. catenularius*, *H. escharoides*, and *H. labyrinthica*, under the first of these names. [2] Under *H. catenularius*, these authors included *H. labryinthica*, Goldf., the same of both Fischer de Waldheim and Bronn, and *H. escharoides* of Lonsdale in 1839, and Hall. [3] Includes *H. labyrinthica*, Goldf., with *H. catenularius*, Linn. [4] Included *H. catenularius*, Linn., *H. escharoides*, Lamk., and *H. labyrinthica*, Goldf., in one. [5] Combining the characters of his *H. catenularius* and its varieties. [6] *H. escharoides*, Hall, was referred to *H. catenularius*, Linn., by Milne-Edwards and Haime in 1854. [7] Including *H. escharoides*, Goldf., and *H. jacovicki*, F. de W.

In the foregoing table I have endeavoured to portray, imperfectly I am afraid, the principal characters assigned to the two species by the more important authors. It exemplifies how difficult it is to say, with our present imperfect knowledge of the two corals, what is *H. catenularius*, Linn., and *H. escharoides*, Lamk., respectively. Upon this point depends, it seems to me, the validity of all other specific names from time to time proposed in *Halysites*. If specific variation is to be accepted as of any value at all, more particularly as applied to stratigraphy, it appears impossible that such apparently different types, as for instance *H. catenularius*, Nicholson, Počta, Lambe, &c., *H. escharoides*, F.-B., *H. elegans*, F.-B., *H. gracilis*, Lambe, the vars. *quebecensis*, Lambe, *nitida*, Lambe, *simplex*, Lambe, *H. cavernosa*, F.-B., and many others, can be one or other of the restricted Edwardsian forms, as the case may be. Rominger remarked[1] on the difficulty of arriving at specific separation through the "great variability of form" existing among his Michigan corals, but at the same time he appears to have been struck with the fact that "various specific forms exist." Prof. Nicholson and the Writer again, in 1880, wrote as follows:[2]—"We hardly think that it is at present possible to define with certainty the different species of the genus *Halysites*. A very vast mass of material will have to be submitted to microscopic examination before it will be possible for the observer to assert positively whether the above-mentioned important structural differences are constant and of specific value, or whether they are merely due to individual variation, or referable to other causes, such as the influence of sex, the temporary condition of the corallum as to the production of ova, or of the actual dimorphism or polymorphism of the species."

No one has more fully recognised the difficulties of specific determination in this genus than Mr. Lambe, who says[3]:—"If an arrangement according to the outside form be attempted, or if the inner structure be relied on only as a basis for classification, it will be found almost impossible to arrive at satisfactory conclusions." This expression of opinion is, however, somewhat discounted by the apparently contradictory statement that "the variations in the general manner of growth of the corallum . . . . and the marked differences to be found in the inside structure appear to be sufficiently constant at different geological horizons to allow of varieties with certain characteristics

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[1] Rominger, Report Geol. Survey Michigan—Lower Peninsula, 1873-76, III, Pt. 2, 1878, p. 78.

[2] Nicholson and Etheridge, Mon. Sil. Foss. Girvan, 1880, Pt. 3, p. 276.

[3] Lambe, Contrib. Canadian Pal., IV, Pt. 1, 1899, p. 65.

being considered distinctive of the horizons in which they are found :" [1] and again :—" It is found, however, that the *Halysites* of different geological horizons have distinctive characteristics which are apparently constant." [2] What is this but specific distinction ?

On this horizon question, a previous writer, Prof. R. P. Whitfield, speaking of the *Halysites* of the Niagara Formation of Wisconsin, remarked :[3]— " It is also noticed that the specimens of the three varieties do not usually occur at the same locality, or if so, that some one of the varieties will greatly predominate, either at the locality or in a certain horizon, while the others are present only in limited numbers."

Either, therefore, Nicholson's views of the di- or polymorphism of the corallum is correct, and equally so Lambe's system of relegating all the Canadian forms but one to the position of varieties of *H. catenularius* is equally correct, the only differentiation being that of geological horizon ; or, on the other hand, there are more than the two principal specific types selected by Milne-Edwards and Haime. From the point of view of practical Palæontology as an aid to stratigraphy, it appears to me the better course to pursue, pending the appearance of a complete Monograph on the whole supposed species constituting the genus, will be to regard all well-marked forms, such as many of Mr. Lambe's are, as distinct species. This is the course I have pursued in regard to our Australian forms, for whatever may be the case with European and American species, I am able to differentiate the first both by external characters on a broad scale, aided by the internal structure.

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[1] Lambe, *Loc. cit.*, p. 65.

[2] Lambe, *Loc. cit.*, p. 67.

[3] Whitfield in Chamberlin, Geol. Wisconsin—Survey, 1873-79, IV, Pt. 3, 1882, p. 271.

IV.—THE GENERAL STRUCTURE OF AUSTRALIAN HALYSITES.

1. *Mode of Preservation.*—All the specimens I have examined are calcareo-siliceous, *i.e.*, traces of the original calcareous tissue are retained in places, but the greater portion of each corallum has either been simply silicified, or has undergone a secondary change, and is converted, more or less, into chalcedony, and Beekite rosettes are often visible on the exterior of the walls. The entombing matrix being in a great measure calcareous, the resulting weathered specimens are, as a rule, in a beautiful state of preservation. Some are far more silicified than others, and in a few exceptional cases secondary silicification is carried sufficiently far to obliterate in a great measure structural details.

2. *Form and Dimensions.*—No absolutely perfect corallum has come under my notice. The growth outline of the *Halysites* found in N. S. Wales appears to be restricted to three types—(*a*) a lax and spreading shrub—like corallum forming masses up to eight inches in height by nine inches in width; (*b*) expanding sub-pyriform colonies, the component corallites radiating, but not curving, from a comparatively narrow base of attachment (*H. lithostrotonoides*, *H. Süssmilchi*, &c.), forming masses up to seven inches high by six wide on the upper surface; (*c*) thick tabular masses (*H. perestephesicus*, &c.), ranging up to two feet long by ten inches wide, but the total height unknown. I have not seen sufficiently perfect examples of either the Queensland or Tasmanian corals to be able to speak with any certainty as to their forms, nor have I observed any trace of a *Syringopora*-like growth in corals such as referred to by Prof. H. A. Nicholson[1] in connection with *H. catenularius*, var. *Fieldeni*, Eth.[2] In this instance I do not quite understand my late friend's remarks. Although referring to the variety as of peculiar growth, Mr. Etheridge does not in any way allude to the presence of connecting tubes between the corallites, and one can only surmise that a re-examination of the type revealed these to Prof. Nicholson.

3. *Mode of Attachment.*—Dr. Fisher-Benzon says his example of *H. parallela*, F. Schmidt, was attached to a *Cyathophyllum*.[3] Of two specimens in the Geological Survey Collection one has every appearance of being adherent

[1] Nicholson, Man. Palæontology, 3rd Edit., 1889, p. 340.
[2] Etheridge, Quart. Journ. Geol. Soc., 1878, XXXIV, p. 583.
[3] Fisher-Benzon, Abhandl. Gebeite Naturwis. Verein Hamburg, V, 2 Abth., 1871, p. 20.

to a *Favosites*, and the other to a *Heliolites*, but in both cases the area of attachment is restricted by the form of the supporting coral. In other species (*e.g.*, *H. cratus*) there is every appearance of a much expanded base, as if the colonies had adhered to a large object, neither is this surface in one plane, but undulating and uneven. Nicholson says the colony of *Halysites* in the early condition is not unlike that of an *Aulopora*.[1]

4. *Epitheca.*—The epitheca, notwithstanding the change in mineral composition, is usually well displayed on the exterior of the corallites as fine, closely set, fluctuating, or rolling, transverse lines, continuous around all sides of the fenestrules. As Nicholson has observed,[2] it does not take any part in the formation of the transverse walls bounding the larger corallites. From Mr. Etheridge's remarks on his *H. catenularius*, var. *Fieldeni* from the Arctic Region, already referred to, it would appear as if a basal epitheca existed also.

5. *Fenestrules.*—These are the "masse lacuneuse" and "irregular reticulations" of Milne-Edwards and Haime, and the "interspaces" of Lambe. The fenestrules are enclosed by the union of the corallite chains, and vary considerably in size within certain limits; from two millimetres in both diameters up to fourteen millimetres by twelve, twenty-three by one, and twenty-five by three. The outline is subject to much variation, they may be round, oval, polygonal, labyrinthine, convoluted, irregularly oblong, or almost square, even S— and dumb-bell shaped; the polygons, usually longer in one diameter than the other, may be pentagonal, hexagonal, or heptagonal. The walls, which are equally the coalesced corallite walls, are always strong, and either flat and barely ribbed longitudinally, or transversely undulate in varying degrees, owing to the more or less farcimentiferous outline of the corallite chains. On the whole, the largest fenestrules appear to be in *H. australis*. There is not any particular arrangement of these interspaces except in one species (*H. peristephesicus*), where there appears to be an effort to cluster or revolve round certain centres.

6. *Corallite Chains.*—I employ the term corallite chain to distinguish the zooidal apertures arranged in linear sequence along each angle of a fenestrule, and by ultimate intersection enclosing the latter. They are to some extent the "grandes lames flabelliformes" of Milne-Edwards and Haime, and the "lamina" of Nicholson and Lambe. The outline of a chain depends

[1] Nicholson, Man. Palæontology, 3rd Edit., 1889, p. 339.

[2] Nicholson, Tab. Corals Pal. Period, 1879, p. 227.

on the form of the corallites composing it, both autopores and mesopores, and appears to be one of the best of the minor macroscopic characters for specific distinction. The length of each chain depends naturally on the number of corallites composing it, and its outline on the degree of farcimenticity of the line of corallite openings. This sausage-string-like outline is least marked in *H. lithostrotonoides* and *H. australis*, and very strongly so in *H. pycnoblastoides*, *H. peristephiscus*, and *H. cratus*. The more geometric the outline of a fenestrule the shorter will be the chains bounding it, as in *H. lithostrotonoides*. As a general rule, the chains surrounding a fenestrule all originate from gonopores at the angles of the latter, but in some species, the chains not only do this, but also unite with one another in the centre of their straight courses, or in the case of a form possessing very labyrinthine fenestrules from the rolling side of the latter.

7. *Imperfect Chains.*—It occasionally happens that a chain of corallites is incomplete, projecting into an already completed fenestrule, without attachment at its distal or outer end. This will be more fully treated of under *Reproduction.*

8. *Form and Structure of Corallites.*—The corallites are cylindroidal, quadrangular, or polygonal, according to their position in a chain. As a rule, the cylindroidal are the largest tubes, and are termed autopores ; the polygonal are the medium in size, and the quadrangular the smallest, called by me the gonopores and mesopores respectively. It is customary to describe the corallum as consisting of corallites of two orders only—the "normal corallites" of Nicholson, or "autopores" of Sardesson,[1] and the "interstitial tubes" of Nicholson, or "tubules" of Lambe. I use the term autopore as Sardesson did, to imply the large cylindroidal corallites; and I borrow the term mesopore for the smaller tubes in a chain, interpolated between the larger, first indicated by McCoy and Hall, and subsequently by Lindström. I am further of opinion that a third set of corallites exists, which I term gonopores. In general terms, it may be stated that all the corallites are long and tubular, and all the enclosing walls are imperforate.

(*a*) *Autopores.*—In the Australian species these are always the largest in the colony, and are invariably cylindroidal, placed end to end, when not separated by a mesopore in the chain line, or by a gonopore at the fenestrule angles. The autopores vary in outline to some extent—they may be oval,

[1] Sardesson, Neues Jahr. Min., Beil.-Bd. V, Heft 2, p. 272.

long-oval, round-oval, almost completely circular, or nearly quadrangular. The autopores are always tabulate; and when septal spines are present, they occur in these tubes.

(*b*) *Mesopores.*—These tubes vary very much in form and size. In the Chillagoe and Tasmanian corals, possibly identical, mesopores seem to be absent; but as the specimens I have seen are not in too good a state of preservation, I do not lay great stress on this point. In *H. orthopteroides* the mesopores are reduced to mere slits; in *H. australis*, *H. cratus*, *H. lithostrotonoides*, and *H. pycnoblastoides*, the outline varies from quadrangular to oblong (parallelogrammatic). In *H. peristephesicus*, these tubes are oblong only, and in *H. Süssmilchi* triangular, quadrangular, or oblong. In the last species, and in *H. gamboolicus*, they are sometimes double. The outlines of any of the mesopores are sometimes modified, so far as the angles are concerned, by subsequent thickening, or secondary siliceous alteration. The presence of more than one mesopore between two autopores is interesting, because it tends to bear out statements to this effect made by other authors. Fischer-Benzon figured[1] double and even treble mesopores in his *H. cavernosa*, and Steinmann copied[2] his figure, referring it to *H. catenularius*, Linn. Weissermel also described[3] the presence of more than one mesopore between two autopores in the same species; and he also figured[4] two between the autopores in a specimen referred to *H. approximata*, Eichw. At the same time, the more complex mesoporal structures figured by Fischer-Benzon have not come under my notice. The mesopores are invariably the smallest zooids in the corallum, and there is not the least approach to the remarkable equality in diameter between them and the autopores figured by Lambe in his *H. catenularius*, var. *amplitabulata*.[5]

(*c*) *Gonopores.*—I employ this term to distinguish the corallites, more often than not, occupying the angles of the fenestrules, and from which in nearly every case new chains arise; they always lie between two autopores. I find that, within certain limits, they are of a different shape to either the autopores or mesopores of a given species, and are always either intermediate in size, or nearly equal to that of the autopores. Furthermore, in some cases, although not in all, the tabulæ are differently spaced to those of the other

[1] Fischer-Benzon, Abhandl. Gebeite Naturwis. Verein Hamburg, V, 2 Abth., 1871, t. 1, f. 2.

[2] Steinmann, Elemente Pal., 1890, p. 109, f. 3 A.

[3] Weissermel, Zeit. Deutschen Geol. Gesellsch., XLVII, 3 Heft, 1894, p. 661.

[4] Weissermel, *Ibid.*, p. 662, f. 4.

[5] Lambe, Contrib. Canadian Pal., IV, Pt. 1, 1899, pl. iv, f. 4*a*.

tubes. If, therefore, a distinction is to be made between the "normal" corallites and the "interstitial tubes," or "tubules," I fail to see why a third group of zooids should not be recognised, provided such zooids can be shown to possess distinctive features of their own. They are always larger than the mesopores, and usually less than the autopores, are always non-septate, and present in all the Australian species; but in three of the latter, these gonopores are not invariably present at every fenestrule angle. They may be recognised by their outline, triangular or quadrangular, irrespective of position; but the commoner outline is polygonal, the hexagonal predominating. Instances of more than one gonopore at a fenestrule angle have been observed, double as in the case of some mesopores, and even triple are occasionally seen, and here and there the geometric outline is departed from, the latter becoming irregular, such as longitudinally elongated, or bent in their course. Like the mesopores, the gonopores are liable to be filled up by stereoplasmic matter, and then become more or less obliterated. It may be taken for granted that the shorter the corallite chains the more numerous the gonopores. A good illustration of the hexagonal form will be found in that of *H. labyrinthica*, by Fischer-Benzon[1]; and Počta figures[2] a gonopore in *H. catenularius*, showing loss of outline from the deposition of secondary matter. The gonopores are intimately associated with the gemmation to be referred to later.

9. *Corallite Walls.*—The walls of all the corallites vary in thickness in ratio to the amount of secondary alteration the tissues have undergone, and their condition can only be accepted in a secondary sense as a feature influencing specific determination. In some instances the transverse or mesoporal walls are traversed by dark lines, apparently representing the primordial walls. When secondary silicification has not been carried to an extreme extent, the walls have a fibrous appearance; but I have not been able to distinguish a similar difference in structure to that described by Sardesson[3] between the fenestrule, or main walls, and the transverse or mesoporal walls. When secondary silicification is carried to its most extreme condition, the walls, particularly the main or fenestrule, are more or less entirely destroyed by conversion into chalcedonic blebs.

10. *Septal Spines.*—These have been detected in five of our forms, and are thorn or spine-like protuberances extending into the visceral chambers for variable distances. The cycles between any two tabulæ vary from two to three, and in only one instance have I been able to satisfactorily count the

[1] Fischer-Benzon, Abhandl. Gebeite Naturwis. Verein Hamburg, V, 2 Abth., 1871, pl. 1, f. 9.
[2] Počta, Barrande's Syst. Sil. Bohême, VIII (ii), 1902, pl. cxvi, f. 5.
[3] Sardesson, Neues Jahrb. Min., Beil.-Bd. X, 2 Heft, 1896, p. 273.

number in a cycle, and am led to believe that it does not exceed twelve. The spines are confined strictly to the outer or autoporal walls, except in a few of the autopores of *H. australis*, where one takes its origin from each of the transverse or mesoporal walls, as shown by Fischer-Benzon in his *H. obliqua*,[1] or by Lambe, both in his figure of *H. catenularius*,[2] and that of the var. *gracilis*, Hall.[3] Similarly, I have not seen septal spines in the mesopores proper, as in Nicholson's figure[4] of those in *H. catenularius*.

11. *False Columella.*—No trace of a false columella has been seen in any of the Australian *Halysites*, although in *H. australis* the septal spines meet at the calicinal centre without coalescing.

12. *Tabulæ.*—Tabulæ are particularly well developed in all three forms of zooids throughout the Australian species. As a rule, they are complete, and there is but little evidence of vesicular structure, as in some exotic forms. For instance, the frequent anastomosis of the autoporal tabulæ figured by Nicholson in *H. catenularius*, Linn., in *H. cavernosa*, by Fischer-Benzon, and more particularly by Steinmann in his conception of the first-named species, has not been observed. Not a single instance of the highly vesicular nature of the mesoporal tabulæ, like that of *H. cavernosa*, F.-B., nor the crowded lenticular vesicles of Lambe's var. *amplitabulata*, nor yet the arched tabulæ of *H. catenularius* proper, of the same author, have been seen. In nearly all our corals, these diaphragms may be said to be distant from one another, and, as a rule, equidistant, but here and there occasional patches of close tabulæ are met with. They may be on the same level in contiguous autopores, or alternate, and mostly horizontal; but oblique, concave, bent, or rolling floors, have been noticed.

The mesoporal tabulæ are horizontal and regular, sometimes on the same level as those of bounding autopores, at other times alternate

The gonoporal tabulæ are generally similar to those of the mesopores. As regards their distance apart, they are, as a rule, intermediate between those of the other two zooids. Rolling tabulæ were observed in *H. pycnoblastoides*.

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[1] Fischer-Benzon, Abhandl. Gebeite Naturwis. Verein Hamburg, V, 2 Abth., 1871, pl. ii, f. 5.

[2] Lambe, Contrib. Canadian Pal., IV, Pt. 1, 1899, pl. iii, f. 2*a*.

[3] Lambe, *Ibid.*, pl. iii, f. 5*a*.

[4] Nicholson, Tab. Corals Pal. Period, 1879, pl. xi, f. 1.

13. *Gemmation.*—This is an intricate and difficult branch of the subject, for very little appears to be known about the initiatory stages of *Halysites*; and I regret that the Australian species do not assist in a solution of the problem. Lindström, in 1873, seems to have been the first, so far as I can gather, to refer to the early stage of this coral. He compared[1] its commencement to that of *Heliolites*, and said—"From the cœnenchyma [? mesopore] which is formed on one side of the first calyx, a new calyx is produced, and beside this another one, so that one can say that Halysites is a Heliolithid, in which the calices form a line with one another, and not round each other. With full-grown and large Halysites colonies, the budding takes place in the same way, calices grow out of the cœnenchyma as in the Heliolithids."

I cannot find any reference on this important matter by Nicholson in his work, "Tabulate Corals of the Palæozoic Period"; but in the last edition of the "Manual,"[2] he states that increase takes place by "stolonal gemmation." According to the late Prof. F. Roemer,[3] the first condition of growth was unknown at the time he wrote. If I understand his remarks rightly, he believed that cells arose on opposite sides from a mother-cell, further propagation taking place by lateral budding; this is not far removed from the previously expressed view of Lindström.

The observations of Počta are of importance, as he appears to foreshadow a dual form of budding, such as I believe to exist, as well as a modified form of earlier stolonal gemmation. Počta says:[4] "Reproduction is effected by lateral budding. Upon the mother-cell there rises a bud with a circular section; the latter becomes elliptic, when the corallite unites with a neighbouring new cell. . . . . Budding may take place, not only on the narrow margin of the cell, but also on the broad [*i.e.*, lateral] side. Upon the former, the new corallite continues the range [*i.e*, chain of corallites]; on the other hand, upon the latter it forms the commencement of a new ribbon [*i.e.*, chain of corallites], which extends by the further addition of new cells."[5] I take it that his *côté étroit* (which I have translated narrow margin) refers to the mesoporal or cross-wall, transverse to the line of growth; and so his *côté large*, I have rendered lateral margin. This can only refer to the

[1] Lindström, Öfvers. K. Vet.-Akad. Forhandl. Stockholm, 1873, No. 4, p. 16.

[2] Nicholson, Manual Pal., 3rd edit., 1889, p. 339.

[3] Roemer, Lethæa Pal., 2 Lief., 1883, p. 484.

[4] Počta, Barrande's Syst. Sil. Bohême, VIII (ii), 1902, p. 274.

[5] Počta, Barrande's Syst. Sil. Bohême, VIII (ii), 1902, p. 274.

long or epitheeate wall of each corallite, particularly as the zooid so produeed forms the commeneement of a "nouveau ruban," and invariably marks the point of deflection of one or more chains, to assist in enclosing a fenestrule. That corallites oeeur at the fenestrule angles, differing in outline from the other two kinds of tubes, seems to be just the point missed by Počta. That these exist needs no further demonstration; that their funetion when present was to produee new chains of corallites, is equally apparent. It seems to me, therefore, that in *Halysites* there is evidenee of (*a*) gemmation from the walls of either autopores or mesopores; and (*b*) budding from a set of speeially eonstituted zooids usually oeeupying that position in the eolony forming the angles of the fenestrules. The existenee of incomplete chains protruding into already formed fenestrules, and commeneing their eourse from a gonopore, either at one of the re-entering angles, or an obtuse angle on one of the sides of a fenestrule, bears out my view of the reproduetive nature of the gonopores. My eontention is also supported by figures of the very young state of forms referred to *H. catenularius*, Linn., and *H. escharoides*, Lamk., by Mr. C. Wiman.[1]

14. *Species.*—I have subdivided the Australian *Halysites* into nine species. As already explained, I find it impossible to refer these to old-world or Amerieau forms; but I have endeavoured to indieate, wherever possible, an alliance with the latter. The eight species are—

Halysites lithostrotonoides, sp. nov.
,, *orthopteroides*, ,,
,, *Süssmilchi*, ,,
,, *cratus*, ,,
,, *australis*, Eth., fil.
,, *pycnoblastoides*, sp. nov.
,, *peristephesicus*, ,,
,, *gamboolicus*, ,,
,, *chillagoensis*, ,,

[1] Wiman, Bull. Geol. Inst. Univ. Upsala, V, Pt. 2, No. 10, 1902, pl. vii, f. 1 and 2, 6-8.

V.—DESCRIPTION OF THE SPECIES.

Genus—HALYSITES, *Fischer de Waldheim*, 1813.

(Zoognosia, 3rd. Edit., 1813, p. 287.)

A.—Spiniform Septa absent.

Halysites lithostrotonoides,[1] *sp. nov.*

(Plate I, Fig. 1; Pl. IV, Figs. 1 and 2; Pl. IX, Fig. 4.)

Sp. Char.—Corallum consisting of a pyriform bunch of corallites subradiate from a common base, forming colonies at least five inches high and four inches wide. Fenestrules polygonal (pentagonal, hexagonal, and heptagonal), occasionally irregular or labyrinthine, but, on the whole, very regular, compact, and reminding one of a roughly-laid tesselated pavement; sizes 2 x 2 mm., 3 x 2 mm., 4 x 2 mm., 5 x 1 mm., 5 x 2 mm., and so on; margins nearly straight, in one alignment; walls flat, *i.e.*, in one plane, and to all intents and purposes level, barely at all ribbed or corrugate. Corallites, in general, long. Epitheca, transversely striate. Corallite chains farcimentiform only in the very slightest degree, hardly at all undulating the outlines of the fenestrules. Autopores long, parallelogrammatic, and very regular in form, margins straight; from one to four in each corallite chain, five being the greatest number observed, and three the average; from three-quarters to one millimetre in length by one-third millimetre in width; visceral chambers nearly square in longitudinal section; tabulæ complete, horizontal, half millimetre apart. Gonopores larger than the mesopores, polygonal (pentagonal, or hexagonal), and a few quadrangular; walls as thick as those of the mesopores. Mesopores quadrangular to parallelogrammatic, and narrow; longest diameter about one-quarter millimetre, at right angles to the direction of the corallite chains; walls less in width than those of the autopores, and often showing a dark dividing line; tabulæ complete, horizontal, one-quarter millimetre apart; visceral chambers longitudinally parallelogrammatic.

Obs.—This coral, viewed macroscopically, presents a very regular and compact appearance; so much so, that when the corallites are seen, either in weathered condition or in transverse section, the autopores and mesopores have a general resemblance to the septate filamentary thallus of an alga, and the united chains to a roughly-laid tesselated pavement.

The farcimentiferous outline of the corallite chains is all but absent, and, in consequence, the margins of the calices are nearly straight in one continuous alignment, and the faint corrugation of the fenestrule walls, as a

[1] λιθόστρωτον, τό—"a tesselated pavement," and *oides*—"resemblance."

whole, is insufficient to break the regular continuity of the fenestrule margins. So strong a contrast is presented by this character to that prevailing in the other species that examples of *H. lithostrotonoides* can be at once picked out with the aid of the naked eye alone.

The horizontal position of the complete tabulæ is maintained with great regularity, very rarely an oblique or concave partition occurs. Increase by gemmation is frequently well exposed in longitudinal weathered sections, with the resulting incomplete chains of corallites. I figure an excellent instance of the commencement of such a chain from an angle of a fenestrule (Pl. IX, Fig. 4), and the gradual building up of the chain.

In one specimen referred to this species, the gonopores at the fenestrule angles are either single, double, or triple. When more than one is present, the additional corallite or corallites are always much smaller than the principal tube. In longitudinal sections, the gonopores can only be distinguished from the autopores by a difference in the diameter, and a slight difference in the distance apart of the tabulæ, which is intermediate between that of the autoporal and mesoporal tabulæ.

The only condition of variation that takes place, other than above, is in a slight increase or decrease, as the case may be, in the size of the fenestrules, and a corresponding difference in the diameters of the three forms of corallites composing a chain, but the number of the latter in a chain is not increased thereby.

The points I rely on for the specific separation of *H. lithostrotonoides* are (1) the regularity of the marginal outline of the corallite chains, whereby the lateral margins of the autopores and mesopores are brought into one alignment, instead of the mesopores occupying re-entrant angles; (2) the consequent absence of a farcimentiform appearance of the corallites.

In its continuous and barely perceptible farcimentiferous outline of the corallite chains, this species resembles *H. catenularius*, var. *gracilis* (Hall), Lambe,[1] but the other details of structure in the two forms are quite different. The habit of the present coral as regards growth, outline of the fenestrules, and general appearance is that of *H. escharoides*, Lamk., as figured by Goldfuss.[2]

Loc. and Horizon.—Beds *a* and *d*, Spring Creek, Portions 98, 221 and 222, Ph. Barton, Co. Ashburnham (*J. M. Curran* and *C. A. Süssmilch*).

Collections.—Australian Museum and Technical College, Sydney.

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[1] Lambe, Contrib. Canadian Pal., IV, Pt. 1, 1899, pl. iii, f. 5, 5*a*.

[2] Goldfuss, Petrefacta Germaniæ, 1826, pl. xxv, f. 4*a*-*b*.

Halysites orthopteroides,[1] *sp. nov.*

(Pl. III, Figs. 1 and 2; Pl. VII, Figs. 4 and 5.)

Sp. Char.—Corallum massive, formed by large colonies, several inches in diameter, of parallel and non-radiate corallites. Fenestrules large, polygonal, labyrinthine, curved, or generally irregular in form, with pronounced angles, or wholly rounded outlines; sizes 6 x 5 mm., 8 x 4 mm., 10 x 5 mm., 12 x 5 mm., 18 x 3 mm., 20 x 5 mm., and so on; margins rather waved; walls strongly corrugate. Corallites very long, tall (at least five inches, and then incomplete), parallel. Epitheca very regularly and coarsely striate. Corallite chains moderately fareimentiform, slightly undulating the margins of the fenestrules. Autopores large, long-oval, but without square or truncate ends, lateral margins rounded, two to nine in each corallite chain, four being the average number, from one to one and a quarter millimetres in length by three-quarters to one millimetre in breadth; visceral chambers transversely elongate (parallelogrammatic); tabulæ complete, horizontal or concave, variable in their distance apart, but usually half a millimetre. Gonopores very much larger than the mesopores, triangular, the sides either straight or concave, sometimes one of the angles truncate; walls as thick as those of the mesopores; visceral chambers nearly rectangular; tabulæ complete, horizontal, one-third millimetre apart. Mesopores transversely[2] elongate (parallelogrammatic), reduced to mere slits, or absent; visceral chambers longitudinally[3] elongate, very narrow; tabulæ complete, horizontal, one-quarter millimetre apart.

Obs.—This species is remarkable for the length and regularity of growth of its corallites, the constant and peculiar form of its gonopores, and the narrow and slit-like nature of the mesopores, when present. In its erect and compact manner of growth it resembles *H. cratus*, more than any other Australian species; but the relative sizes of the autopores will at once distinguish the two forms, to say nothing of the peculiarities of the other two sets of zooids just indicated.

When a corallum is viewed macroscopically from above, without relation to the mode of growth or length of corallites, *H. orthopteroides* might at first sight be mistaken for *H. Sussmilchi*, but the fenestrules are more labyrinthine than those of the latter; and what is of more importance,

[1] *ὀρθόπτερος*—"with high or upright columns," and *oides*—"resemblance."

[2] That is to say, at right angles to the direction of growth of a corallite chain.

[3] That is to say, parallel to the general growth of the corallum.

the fareimentiferous outline of the autopores is much less marked than in the latter. Furthermore, the alignment of the corallites in a chain is more continuous and unbroken in the present species than it is in *H. Sussmilchi*, as the mesopores do not occur in re-entrant spaces, although the alignment in *H. orthopteroides* is not so continuous as in *H. lithostrotonoides*.

The reduction of the mesopores to mere slits is not due to infilling, or thickening of the tissues, but is structural; the proportion of mesopores present or absent is about equal, and when these zooids are not present the autopores abut against one another, and are only separated by the intervening walls.

The regular triangular outline of the gonopores, and the frequent truncation of one of the angles, are very characteristic features in this species. The alignment of the corallite chain margins is more or less regular, like those of *H. lithostronoides*, and in consequence, those of *H. catenularius*, var. *gracilis* (Hall), Lambe.

Loc. and Horizon.—L. Smith's Station, Portion 98, Pl. Gamboola, Co. Wellington (*C. Cullen*).

Collection.—Mining and Geological Museum, Sydney.

Halysites Süssmilchi, *sp. nov.*

(Pl. III, Figs. 3 and 4; Pl. VII, Figs. 1–3.)

Sp. Char.—Corallum expanding sub-pyriform, the parent corallites sub-radiate from a common base, forming colonies up to seven and a half inches high by six inches wide. Fenestrules variable in size, and particularly in outline, round, oval, elongate, S-shaped, dumb-bell shaped, roughly polygonal, labyrinthine, or quite irregular, but, as a rule, one axis greatly exceeds the other; sizes 3 x 3 mm., 5 x 5 mm., 9 x 2 mm., 10 x 3 mm., 12 x 5 mm., 15 x 3 mm., and so on, up to 25 mm. in length; margins strongly undulate; walls coarsely and strongly corrugate or ribbed. Epitheca coarsely striate. Corallites long, at least four inches, and then imperfect. Corallite chains strongly fareimentiform. Autopores round or round-oval, from five to twenty-five in each corallite chain; length, one to one and a half millimetres by one in breadth; visceral chambers transversely elongate (parallelogrammatic); tabulæ well developed, complete, horizontal, half a millimetre apart. Gonopores well developed, triangular, quadrangular, or polygonal; tabulæ complete, horizontal, one-third of a millimetre apart; walls of equal thickness to those of the autopores. Mesopores well developed,

in long re-entrant spaces, rectangular and narrow transversely, half to one-third millimetres in longest diameter by half a millimetre in width, but by a rounding of the angles sometimes becoming oval, occasionally double; visceral chambers transversely oblong; tabulæ complete, close, horizontal, or oblique, one-quarter of a millimetre apart.

Obs.—*Halysites Süssmilchi* is so distinct from the other non-septate forms, that the points of divergence need hardly be referred to; however, the oval or round outline of the autopores and the re-entrant spaces occupied by the mesopores produce equally apparent undulating margins to the fenestrules, the mesopores separating the autopores by well-defined interspaces, a very different appearance to that noticeable in *H. lithostrotonoides*, &c. In a lateral view of a weathered corallum, the oval or round outline of the autopores conveys to the fenestrule walls a highly-ribbed or fluted appearance, producing on the whole much the aspect of a sheet of corrugated galvanised iron.

The labyrinthine or irregular outline of many of the fenestrules seems to be a prominent feature in this species; still, there is not the same rambling habit of growth as in *H. australis*, in which the fenestrules are equally irregular. Again, like the latter, *H. Süssmilchi* is one of the forms in which secondary silicification has been carried to the greatest extent. The outline of the autopores and deep re-entrant spaces between them containing the mesopores, resemble those of one of Nicholson's figures[1] of *H. catenularius;* similarly, there are no septa.

Loc. and Horizon.—Bed *d*, Spring Creek, Portion 221, Ph. Barton, Co. Ashburnham (*J. M. Curran* and *C. A. Süssmilch*).

Collections.—Australian Museum, and Technical College, Sydney.

Halysites cratus,[2] *sp. nov.*

(Pl. I, Figs. 2 and 3; Pl. IV, Figs. 3 and 4; Pl. VI, Figs. 5 and 6.)

Sp. Char.—Corallum massive, forming large tabular colonies of parallel and non-radiating corallites up to eight inches by five inches in size. Fenestrules large, as a rule longer than wide, some quadrangular, a few polygonal, but the geometric outline always obscure, the majority being curved, labyrinthine, or quite irregular in outline, and often almost linear; sizes 5 x 5 mm., 7 x 4 mm., 6 x 5 mm., 10 x 1 mm., 11 x 2 mm, 14 x 3 mm.; margins highly

[1] Nicholson, Tab. Corals Pal. Period, 1879, pl. x, f. 7.

[2] κρᾰτὺς—"robust."

undulate; walls strongly corrugate. Corallites very long, up to eight inches, parallel. Epitheca coarsely striate. Corallite chains highly farcimentiform, often contiguous laterally. Autopores very large, oval to circular, the latter forming a conspicuous feature; from one to six in each corallite chain, the average being four, from one and a half to two millimetres by one to one and a half millimetres in diameter, or at times possessing the same diameter in both directions; visceral chambers transversely elongate (parallelogrammatic); tabulæ complete, distant, and very regular, horizontal, or slightly concave, half to three-quarters of a millimetre apart. Gonopores quadrangular, polygonal, or variable in form, sometimes absent at the chain junctions, but when present, always much larger than the mesopores; walls as thick as those of the latter; visceral chambers nearly square; tabulæ complete, equidistant, horizontal, one-third of a millimetre apart. Mesopores numerous, in short but very marked re-entrant spaces, transversely elongate (parallelogrammatic), but not slit-like, half to three-quarters of a millimetre in longitudinal measurement by one-quarter to three-quarters of a millimetre transversely; visceral chambers longitudinally elongate (parallelogrammatic); tabulæ complete, horizontal, one-quarter millimetre apart.

Obs.—H. cratus is a strong and robust species, possessing the largest autopores of any of our *Halysites*, and by the almost circular outline of the latter is readily recognisable. As in *H. orthopteroides*, the corallite chains are very farcimentiform, but whereas the individuality of the autopores arises from the interpolation of long mesopores in the latter, in the present instance the re-entrant spaces containing the mesopores are short, and the sausage-like outline of the corallite chains sensibly increased thereby, and the rotundity of the autopores rendered very conspicuous.

The colonies form large tabular masses like those of *H. peristephesicus*, and possibly also *H. orthopteroides*, but exceeding both in the length of the corallites, and in consequence height of the corallum.

H. cratus is a most interesting species from the fact that many of the chains do not always take their origin from and junction with a gonopore at their opposite ends, but sometimes by the simple interposition of a mesopore. At the same time, gonopores are present both in numbers and normal position; and not only of large size, but in some instances surrounding the chief zooid are other smaller accessory tubes, producing a minute and limited cœnenchyma. When a corallite chain junctions with a mesopore, the latter only differs from the ordinary mesopores regularly interpolated between the

autopores by possessing a square outline. There is, however, this important fact, that if a corallite chain be found to unite with a mesopore at one end, it will be found to junction with a gonopore at the other; this seems to imply that its point of origin is, after all, a gonopore, and the junction of the mesopore is merely to form a re-union with another chain. I give this as a possible solution of the matter.

In a longitudinal section of a few corallites, the disproportion between the diameters of the autopores and mesopores becomes at once apparent. It is in marked contrast to that seen in *H. catenularius*, var. *amplitabulata*, Lambe.

The more important comparative features relied on for the specific separation of this coral are—(1) Large size and round outline of the autopores; (2) short re-entrant spaces between the autopores occupied by the mesopores; (3) marked difference in diameter between the autopores and mesopores; (4) long and almost linear outline of many of the fenestrules.

In the rotundity of the autopores, large size of the mesopores, and irregularly labyrinthine outline of the fenestrules, this species so far resembles one of Lambe's illustrations of *H. catenularius*, Linn.,[2] and *H. regularis*, Fischer-Benzon[3]; indeed, the whole aspect of the latter coral, in sections, is much like the Australian species. One of Počta's enlarged figures[4] of *H. catenularius*, Linn., represents the structure of the present coral very completely when examined in transverse sections.

Loc. and Horizon.—One mile west of Claudius Smith's Homestead, Ph. Copper Hill, Co. Wellington (*C. Cullen*); L. Smith's Station, Portion 98, Ph. Gamboola, Co. Wellington (*C. Cullen*).

Collection.—Mining and Geological Museum, Sydney.

B.—Spiniform Septa present.

Halysites australis, *Eth. fil.*

(Pl. VI, Fig. 1; Pl. VII, Fig. 6; Pl. IX, Figs. 1 and 2.)

Halysites australis, Eth. fil., Rec. Austr. Mus., III, Pt. 4, 1898, p. 78, Pl. XVII.

Sp. Char.—Corallum lax and spreading, or forming loosely constructed shrub-like growths, ultimately uniting with one another to form colonies ranging up to nine inches in height. Fenestrules very variable in form and

[1] Lambe, Contr. Canadian Pal., IV, Pt. 1, 1899, pl. iv, f. 4*a*.
[2] Lambe, *Ibid.*, pl. iii, f. 2, 2*a*.
[3] Fischer-Benzon, Abhandl. Gebiete Naturwis. Vereir Hamburg, V, 2 Abth., 1871, pl. ii, f. 1-3
[4] Počta, Barrande's Syst. Sil. Bohême, VIII (ii), 1902, pl. cii, f 4.

size, quadrangular, polygonal, often of irregular and rounded outline; sizes from 3 x 3 m. up to 15 x 15 m., with intermediate gradations; margins plain, in one alignment, non-fluctuating; walls flat, or with faint broad ribs or corrugations. Complete corallites unknown, but apparently of no great length. Epitheca with delicate, fine, transverse striation. Corallite chains simple, narrow, fareimentiform only in the smallest degree. Autopores oval to long oval, with rounded ends, two to twelve on each corallite chain, the average being from four to six, from three-quarters to one millimetre in longest diameter by half to three-quarters of a millimetre in width; walls very thick, solid, often presenting the appearance as if the zooids were sunk in them; septal spines well developed, long, from one to three cycles in each visceral chamber, according to the distance apart of the tabulæ, all but meeting at the calicinal centres; pseudo-columella not observed; visceral chambers transversely elongate (parallelogrammatic), very variable in longitudinal diameter; tabulæ complete, close or distant, horizontal or oblique, from three to six in the space of one millimetre vertical. Gonopores large and polygonal, here and there triangular, round, or irregular; walls as thick as those of the mesopores; tabulæ complete, horizontal, half a millimetre apart. Mesopores transversely oblong and narrow, the corallites pipe-like to quadrangular and large; visceral chambers longitudinally elongate as a general rule; tabulæ complete and equidistant, horizontal, half a millimetre apart.

Obs.—H. australis is of large and rambling growth, and very variable in some of its characters, particularly the distance apart of the autoporal tabulæ. A large specimen from Molong, in the Geological Survey Collection, indicates that it grew in arborescent bunches commencing from a number of centres of growth, the corallites of one bunch as they grew intermingling with those of another cluster; a colony of this description is nine inches by eight.

In my former description I stated that *H. australis* was devoid of spiniform septa, but by the acquisition of further specimens, and the preparation of a number of additional sections, I find that septal spines are present, but very variable in their development. Some specimens, although possessing all the other features of this species do not exhibit spiniform septa at all, in others they are visible only in the longitudinal sections, and again in a third set are more particularly noticeable in transverse sections. The spines are as usual twelve in a cycle, five springing from each autoporal wall, and one from each meso-autoporal wall, as figured by Fischer-Benzon in

his *H. regularis*,[1] and *H. escharoides*,[2] and by Nicholson again in the latter species.[3] They approximate closely to one another towards the calicinal centres, but in only one instance could I detect any union, and then only of two opposite spines without the formation of a longitudinal pseudo-columella. The number of cycles to a visceral chamber is also variable, one, two, or three, according to the distance apart of the tabulæ.

I also referred to the proximity to one another of the autoporal tabulæ, and the comparative distance apart of those in the mesopores. The latter statement holds good; but the former character in this species, like that of the spiniform septa, is open to much variation, even in the same corallite. The autoporal tabulæ may be quite close, from five to six in the space of one millimetre, or distant, three being contained in the same space. This, although in words a very trivial matter, is in reality an important feature, and presents in a section a most marked difference to that exhibited by the more numerous tabulæ. Another peculiarity is that patches or clusters of the closely-set tabulæ may appear in a group of corallites as the fundamental character of that particular series, and in consequence, several longitudinal sections are necessary, should the observer suspect he is examining a specimen of *H. australis*, before absolute certainty can be arrived at. Once this dual structure of the tabulæ in the autopores has been observed, the distinction I formerly drew between *H. australis* and other species still holds good.

Gonopores, as in *H. cratus*, are not invariably present at the junction of corallite chains, although the absence of this particular form of zooid from its normal position is not common.

The special points that appear to distinguish *H. australis* are—(1) rambling form of growth; (2) comparatively large size of the fenestrules; (3) thickness of the autoporal walls; (4) variability in the distance apart of the autoporal tabulæ; (5) pipe-like form of the mesopores in longitudinal section; (6) length of the spiniform septa, and their tendency to unite at the calicinal centres; (7) occurrence of a septal spine on each auto-mesoporal wall.

The lax and loose rambling habit of this coral is very like that depicted by Mr. R. Etheridge in his *H. catenularius*, var. *Harti*,[4] from the Arctic Regions. In fact, his remarks on the variety named apply equally well, so

[1] Fischer-Benzon, Abhandl. Gebiete Naturwis. Verein Hamburg, V, 2 Abth., 1871, pl. ii, f. 3.
[2] Fischer-Benzon, *Ibid.*, pl. iii, f. 2.
[3] Nicholson, Tab. Corals Pal. Period, 1879, pl. x, f. 6.
[4] Etheridge, Quart. Journ. Geol. Soc., 1878, XXXIV, p. 583, pl. xxviii, f. 2.

far as the external appearance is concerned, to *H. australis*. The growth and outline of the fenestrules is also that of *H. labyrinthica*, Goldf.[1] In the internal structure great similarity exists to that of *H. escharoides* (Lamk.), Fisher-Benzon,[2] and the coral so named by the latter author possesses both autopores and mesopores, as ours does, thus differing from Nicholson's conception of Lamarck's species.

Loc. and Horizon.—Bell River, on L. Smith's Station, Ph. Copper Hill, Co. Wellington, in alternating beds of shale and limestone, the upper beds with *Conchidium Knighti*, Sby. (*J. M. Curran* and *C. A. Süssmilch*); Ph. Copper Hill, Co. Wellington (*C. Cullen*); Suntop, Ponto-road, Ph. Ponto, Co. Lincoln (*C. Cullen*); Geurie, Ph. Guerie, Co. Lincoln (*C. Cullen*); Quedong (*Geol. Survey*).

Collections.—Australian, and Mining and Geological Museums, and Technical College, Sydney.

Halysites pycnoblastoides,[3] *sp. nov.*

(Pl. IV, Figs. 1 and 2; Pl. VIII, Figs. 5 and 6.)

Sp. Char.—Corallum formed of large sub-pyriform masses consisting of slightly radiate corallites, producing colonies up to ten inches by six in size. Fenestrules round, oval, quadrangular, and polygonal, occasionally irregular, but seldom labyrinthine; sizes 2 x 2 mm., 3 x 2 mm., 4 x 2 mm., 5 x 1 mm., 7 x 2 mm., 10 x 1 mm., and so on; margins highly undulate; walls strongly corrugate or ribbed. Epitheca transversely striate. Corallites long, up to five inches (and then imperfect). Corallite chains strongly fareimentiform. Autopores very numerous, oval or round, one to five in a chain, the average two, one and a half millimetres in longest diameter by one millimetre in the opposite direction; septa confined to the autoporal walls only, and distinctly visible with the pocket-lens, arranged in from two to three cycles in each visceral chamber; the latter are transversely elongate (parallelogrammatic); tabulæ complete, horizontal, or at times oblique, about half a millimetre apart. Gonopores very numerous, greatly exceeding the mesopores in number, polygonal or irregular in outline, non-septate; walls as thick as those of the mesopores; visceral chambers transversely oblong (parallelogrammatic); tabulæ complete, horizontal, about one-fourth of a millimetre apart. Mesopores few in number in a corallite chain, but where present large and well developed in re-entrant spaces, and transversely elongate (parallelogrammatic) to quadrangular; visceral chambers nearly square; tabulæ complete, horizontal or rolling, about one-third millimetre apart.

[1] Goldfuss, Petrefacta Germaniæ, 1826, pl. xxv, f. 5*a*.
[2] Fisher-Benzon, Abhandl. Gebeite Naturwis. Verein Hamburg, 1871, V, 2 Abth., pl. iii, f. 1-3.
[3] Πυκνόβλαστος "full of buds," and *οἰδες*—"resemblance."

Obs.—This is a compact and uniformly-grown coral, the corallites when seen in weathered specimens, transverse to the direction of growth, presenting to the naked eye a gemmuliferous appearance, arising from the great difference between the size and shape of the autopores and that of the mesopores, and the limited number of the latter; this resemblance is increased by the re-entrant spaces in which the mesopores are situated.

The limited number of corallites in a chain gives rise to an interesting point of structure, in that the gonopores predominate over the mesopores, so much so that it is very difficult to obtain a longitudinal section of one of the latter; when, however, this is accomplished, the diameter of the tubes, and distance apart of the tabulæ, will readily distinguish the mesopores.

No difficulty need occur in distinguishing *H. pycnoblastoides* from the highly farcimentiform non-septate *H. Süssmilchi*. The former is—(1) a much stronger and more robust species; (2) the fenestrules are constantly and uniformly larger, and with a different outline; (3) the fenestrule walls are more strongly corrugate; (4) the autopores are oval in the former, round in the latter; (5) the re-entrant spaces containing the mesopores much more defined in the latter than in the former.

The first three points will also assist in distinguishing the present species from *H. orthopteroides*, as well as the form of the autopores in the latter, the triangular outline of the gonopores and slit-like mesopores.

The principal features to be noticed in *H. pycnoblastoides* are :—(1) the generally small size and non-angular outline of the fenestrules; (2) highly farcimentiform outline of the corallite chains; (3) plentitude of autopores, but the limited number in each chain; (4) copious development of gonopores; and (5) the less development of mesopores, and absence of septa projecting from their walls.

The outline of the autopores and the large square mesopores place this near *H. catenularius*, var. *nitida*, Lambe,[1] and the longitudinal sections of the two are by no means unlike either. On the other hand the dimensions of the respective parts do not agree.

Loc. and Horizon.—Bed *d*, Spring Creek, Portion 221, Ph. Barton, Co. Ashburnham (*J. M. Curran* and *C. A. Süssmilch*).

Collections.—Australian Museum and Technical College, Sydney.

[1] Lambe, Contrib. Canadian Pal., 1899, IV, Pt. 1, pl. iv, f. 2*a* and *b*.

Halysites peristephesicus,[1] *sp. nov.*

(Plate II ; Plate VIII, Figs. 1 and 2.)

Sp. Char.—Corallum forming large, thick, tabular masses up to two feet long, consisting of long parallel corallites ascending from an extended base of attachment. Fenestrules linear, labyrinthine, or convolute, often very long and clustered, or almost revolving around certain given centres; sizes 2 x 2 mm., 6 x 2 mm., 13 x 1 mm., 18 x 1 mm., 23 x 1 mm., &c.; margins very undulate; walls strongly corrugate or ribbed. Epitheca fine, transversely striate. Corallites long, straight, up to six and eight inches. Corallite chains varying from short to very long, the latter predominating, strongly farcimentiform. Autopores large, from two to twenty in a chain, but with no definite average number, broad oval in outline, with bulging sides, one millimetre, or slightly more in longest diameter, by three-quarters of a millimetre; septa short, in one or two cycles, not developed on the mesoporal walls; visceral chambers generally transversely elongate (parallelogrammatic); tabulæ complete, very regular, horizontal, or occasionally oblique, half a millimetre apart. Gonopores large, very irregularly polygonal, as a rule much longer in one direction than the other, non-septate; visceral chambers nearly square; tabulæ complete, horizontal, one-fifth of a millimetre apart. Mesopores well developed, transversely oblong, non-septate; tabulæ complete, horizontal, one-fourth of a millimetre apart.

Obs.—This is a large and very beautiful form of *Halysites*, and is remarkable for the length and linear appearance of its fenestrules, and so presenting a very marked contrast with *H. pycnoblastoides*. Mr. C. A. Süssmilch informs me that he saw a colony *in situ* which measured two feet long by five inches high and ten inches wide, and showed the extended flat-based tabular form to perfection. No other Australian *Halysites* that I have seen is of so compact a growth with similar long parallel corallites.

Another special feature in this species is the strange tendency the corallite chains seem to have of encircling, hardly revolving, round certain centres[2]; in fact, when viewed as a whole the corallum appears to be made up

[1] Περιστεφὴς—"encircling an object."

[2] Since this description was written, I have seen Mr. R. P. Whitfield's interesting paper—"Observations on a remarkable specimen of Halysites," &c. (*Bull. American. Mus. Nat. Hist.*, 1903, XIX, p. 489), in which he describes a form referred to *H. catenulatus*, Linn., presenting on its upper side the original surface of the coral in about the condition it had while living in the "Silurian seas," and possessing on its upper surface seven "botryoidal or convex bosses" (*loc. cit.* pl. xli, pl. xlii, f. 5.) Mr. Whitfield further remarks on the elongation and compression of the "cell spaces" (our fenestrules) in the spaces between the "bosses." This is also noticeable in the corresponding spaces on the Australian specimens between what I have termed "rosettes" (Pl. ii, Fig. 3). On the other hand, the upward tooth-like extension of the cell walls seen in the American examples is not present, possibly on account of the state of preservation.

of a series of these "rosettes," as if the latter were separate centres of growth that had ultimately united, with here and there interspaces composed of chains assuming a more rambling form of growth. After all, this structure may be more imaginary than real, still such an appearance does exist. I have made use of this character for the specific name.

Certain appearances in one specimen of *H. peristephesicus* led me to hope that I had discovered traces of the base of attachment and commencement of growth of the corallum. Along the uneven base of this particular example is a well-marked line, or series of superimposed lines, of a dark colour on which all the corallites rest. This base is not actually flat and in one plane, but rolling as if accomodating itself to some surface or object of attachment. The examination of thin sections, however, taken along this line, ended in disappointment, for the dark line, or lines, appear to consist of organic material formed of the flocculent matter accompanying Endophytic Fungi, often previously referred to by me in connection with our Palæozoic Corals, and some amount of cellular tissue. I cannot detect any structure that could be construed into a commencement of growth.

Like *H. pycnoblastoides*, this species resembles *H. catenularius*, var. *nitida*, Lambe, in the outline of its autopores and mesopores, and also in the long rambling outline of the fenestrules, but the corallite chains are far too fascimentiform in both the species and variety named to be compared to those of *H. peristephesicus*.

Loc. and Horizon.—Bed *a*, Quarry Creek, Portion 222, Ph. Barton, Co. Ashburnham (*J. M. Curran* and *C. A. Süssmilch*).

Collections.—Australian Museum, and Technical College, Sydney.

Halysites gamboolicus,[1] *sp. nov.*

(Plate V, Figs. 1 and 2; Plate VI, Fig. 3.)

Sp. Char.—Corallum delicate, compact, formed of sub-pyriform to sub-hemispherical masses up to five inches by five inches in size. Fenestrules very irregular in outline small, on the whole, when compared with the other species of similar growth, non-geometric, no two alike, narrow or broad, elongate in either direction without being labyrinthine; sizes 3 x 2 mm., 4 x 2 mm., 5 x 5 mm., 6 x 4 mm., 10 x 3 mm., &c.; margins moderately undulate; walls not highly corrugate or ribbed. Epitheca very fine. Corallites long, slightly radiate.

[1] In allusion to the locality.

Corallite chains fareimentiform, delicately undulating the margins of the fenestrules. Autopores small, delicate, but well developed, oval but square-ended, from two to eight in a chain, the average four, three-quarters of a millimetre in longest diameter by three-quarters in a contrary direction; walls thick; septa confined to the autoporal walls, from two to three cycles in each visceral chamber; the latter transversely elongate (parallelogrammatic) to nearly square; tabulæ complete, distant, horizontal, concave, or now and then rolling, half a millimetre apart. Gonopores numerous, well developed, large, polygonal or irregular in outline, always larger than the mesopores, non-septate; visceral chambers transversely elongate (parallelogramatic); tabulæ complete, horizontal or oblique, one-quarter millimetre apart. Mesopores well developed and constant in position in re-entrant spaces, transversely elongate (parallelogrammatic), often double, or by removal of the central portion of the dividing wall horologiform; walls thick, but less so than those of the autopores; visceral chambers longitudinally elongate; tabulæ complete, horizontal, one-quarter of millimetre apart.

Obs.—This compact form is the most delicate of our *Halysites*, and although resembling *H. pycnoblastoides* in its general habit, is distinguished by its smaller autopores. When viewed macroscopically, the absence of a geometric outline to the fenestrules and the fareimentiform appearance of the corallite chains will at once separate *H. gamboolicus* from *H. lithostrotonoides*. It is interesting to meet with double mesopores in this species, similar to some of those figured by Fischer-Benzon in his *H. cavernosa*[1]; when the intervening central portion of the new wall dividing these mesopores is broken down, a regular hour-glass-shaped figure is the result. The longitudinal or vertical sections of the mesopores resemble those of *H. australis*.

Loc. and Horizon. — Portion 98, Ph. Gamboola, Co. Wellington (*C. Cullen*).

Collection.—Mining and Geological Museum.

Halysites chillagoensis,[2] *sp. nov.*

(Plate V, Figs. 3 and 4; Plate VIII, Fig. 3; Plate IX, Fig. 3.)

Obs.—This coral will be described in detail in one of the Reports of the Geological Survey of Queensland.

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[1] Fischer-Benzon, Abhandl. Gebiete Naturwis. Verein Hamburg, V, 2 Abth., 1871, pl. i, f. 2.

[2] In allusion to the locality.

I have seen only imperfect examples, but the interest attached to it is both of a morphological and geological nature. In some of its characters it approaches closely to those of *H. australis*, and I at one time regarded it merely as a variety of the latter. The entire absence of mesopores (so far as my observation has gone), and the absence of closely-clustered autoporal tabulæ, seem to set it apart; but, at the same time, I accord it specific rank with all reservation. The plan of growth of the colonies appears to be similar to that of *H. australis*, although the fenestrules are of a less rambling habit.

The absence of mesopores is quite apparent on examining longitudinal sections, the autopores abutting closely against one another, the tabulæ of contiguous tubes being either opposite or sub-opposite. The septa are by no means easy to distinguish. They are faintly discernible in a transverse section as short spines, and in the longitudinal as dark dots in the visceral chambers of the autopores, representing the cut ends of the spines projecting from the autoporal walls. The number of cycles appears to be inconstant—one cycle in one visceral chamber, two in others, and possibly three in a few instances.

If the constant absence of mesopores is a specific feature, the Queensland coral is certainly distinct from any of the foregoing. It is at the same time a feature of high morphological importance, for it proves what has been foreshadowed in some of the previous species that gemmation may proceed from autopore to autopore without the intervention of a mesopore.

The first indication of *Halysites* as a Queensland fossil is due to Mr. B. Dunstan, Acting Government Geologist of Queensland, who recorded[1] its occurrence near Mungana, Chillagoe Gold-field.

In 1900 I described[2] a *Halysites*, in a highly altered condition, from the Gordon Limestone at the Mersey River, between Liena and Mole Creeks, Tasmania, forwarded to me by Mr. T. Stephens, M.A., of Hobart. With the exception of two trivial characters, viz., the size and form of the fenestrules, and the presence of concave instead of generally horizontal autoporal tabulæ, the general structure does not appear to differ from that of *H. chillagoensis*. The form and size of the autopores is practically the same, there are the same thick and feebly corrugate lamellar walls, solid and trenchant intercorallite walls, and no mesopores, feeble gonopores, and these not always present (or obliterated?), and small septa. The general resemblance impresses me strongly.

[1] Dunstan.—Some Chillagoe Geological Notes—*Ann. Progress Report Geol. Survey Q'land for* 1900 (1901). p. 21.

[2] Etheridge, Junr., Proc. R. Soc. Tas. for 1898–99 (1900), p. 81.

VI.—DISTRIBUTION OF THE SPECIES IN LOCALITIES.

Species.	Bed *a*, Spring Creek, Barton.	Bed *d*, Spring Creek, Barton.	Bed *a*, Quarry Creek, Barton.	L. Smith's station, Gamboola.	*Conchidium Knighti* beds, Bell River, L. Smith's station, Copper Hill.	1 m. west of C. Smith's homestead, Copper Hill.	Suntop, Ponto-road.	Guerie.	Quedong.	Mungana, Chillagoe Gold-field, Queensland.	Gordon River Limestone, Liena and Mole Creeks, Mersey River, Tas.
Halysites australis	...	...	...	...	x	...	x	x	?	...	.....
,, chillagoensis	...	...	...	...	.....	...	...	...	...	x	?
,, cratus	...	...	...	x	.....	x	...	...	...	...	.....
,, gamboolicus	...	...	...	x	.....	...	...	...	...	...	.....
,, lithostrotonoides	x	x	...	..	.....	...	...	...	...	...	.....
,, orthopteroides	...	...	...	x	.....	...	...	...	...	...	.....
,, peristephesicus	...	...	x	...	.....	...	...	..	...	...	.....
,, pycnoblastoides	...	x	...	...	.....	...	...	...	...	...	.....
,, Sussmilchi	...	x	...	...	.....	...	...	...	...	...	.....

VII.—CONCLUSION.

My study of the Australian *Halysites* compels me to adopt at least one general conclusion. However satisfactorily Nicholson's deductions may suit the European species, they will not hold good for the Australian.

To repeat, Nicholson defined (1) a species with two forms of zooids, and no septal spines (*H. catenularius*, Linn.); and (2) a second species with one form of zooid only, but this provided with septal spines (*H. escharoides*, Lamk.).[1]

Amongst the Australian *Halysites* we find species (1) with both autopores and mesopores and no apparent septa (*H. lithostrotonoides*, *H. orthopteroides*, *H. Sussmilchi*, and *H. cratus*); (2) with both autopores and mesopores, and septal spines (*H. australis*, *H. pycnoblastoides*, *H. peristephesicus*, and *H. gamboolicus*). Possibly, a third group may be represented by the Queensland form (*H. chillagoensis*), in which mesopores seem to be absent.

[1] Nicholson's views received the support of Počta, as already explained.

VIII.—NOTE ON A EUROPEAN SPECIES.

Fischer-Benzon described, under the name of *H. cavernosa*, a *Halysites* in which the tabulæ of the mesopores are incomplete and vesicular. Lambe also figured a Canadian *H. catenularius* (so called) with the mesoporal tabulæ arched, and to some extent vesicular also.

In the Australian Museum Collection is a European coral said to be from Holmestrand in Norway, and labelled *H. labyrinthica*, Goldf. Sections of this (Plate IX, Figs. 5 and 6), prepared for the microscope, exhibit all the characters shown in *H. cavernosa*, F.-B.—wide autopores with occasional incomplete tabulæ, narrow mesopores carrying arched and vesicular tabulæ in longitudinal section, and cellular mesopores in transverse section. In fact, whatever *H. cavernosa*, F.-B., may be, I am convinced this Norwegian coral is also. I am induced to refer to this matter simply in confirmation of some of Fischer-Benzon's observations. The mode of growth, outline, and size of the fenestrules, &c., are certainly those of *H. labyrinthica*, Goldf., and it is possible that the latter and *H. cavernosa* may be identical.

PLATES AND EXPLANATIONS.

The negatives from which Plates I–V are reproduced, and the negatives of sections, represented in Plates VI–IX, were taken at the Australian Museum by Mr. H. Barnes, Junr., and Mr. Thomas Whitelegge, respectively. As now represented, Plates I–V were reproduced by Mr. A. E. Dyer, and Plates VI–IX lithographed by Mr. E. W. Minchin, at the Government Printing Office, Sydney, under the direction of Mr. W. A. Gullick, Government Printer.

PLATE I.

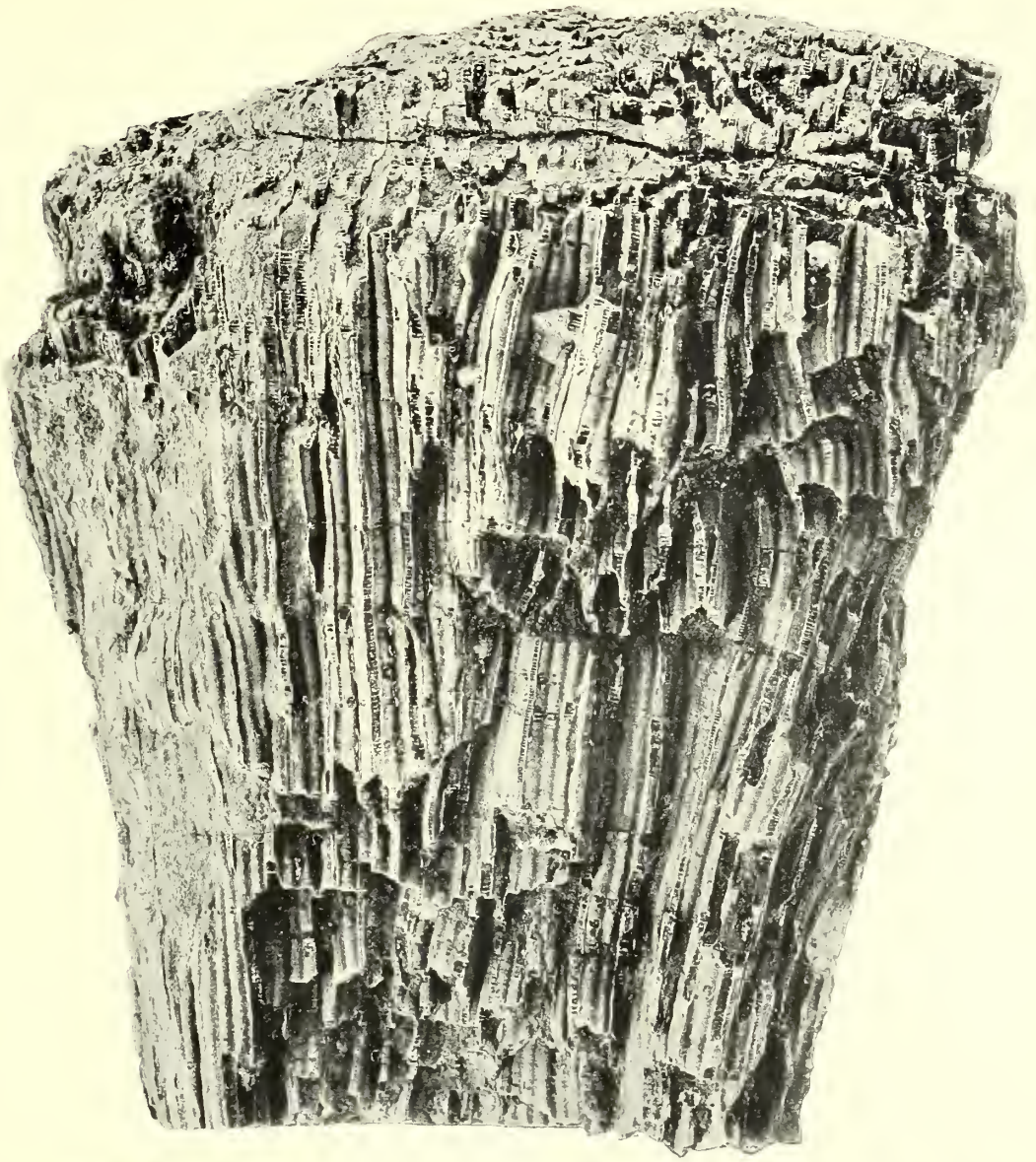
Halysites cratus, *Eth. fil.*

Fig. 1. A large corallum, longitudinal aspect, exhibiting the large autopores, gonopores, and mesopores.

Halysites lithostrotonoides, *Eth. fil.*

Fig. 2. Corallum seen from above, exhibiting the pavement-like form of the fenestrules.

Fig. 3. A larger corallum, longitudinal aspect, exhibiting the comparatively even sides of the fenestrules.



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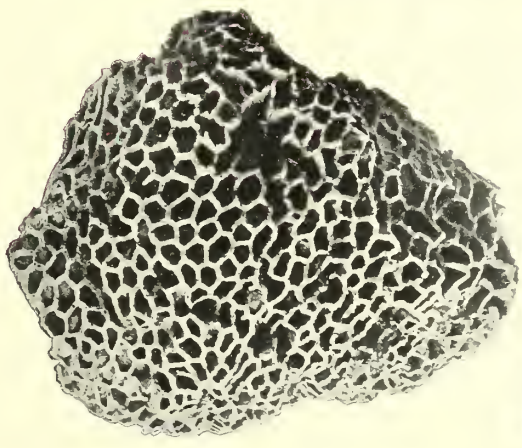

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3

H. Barnes, Junr., photo., Austr. Mus.

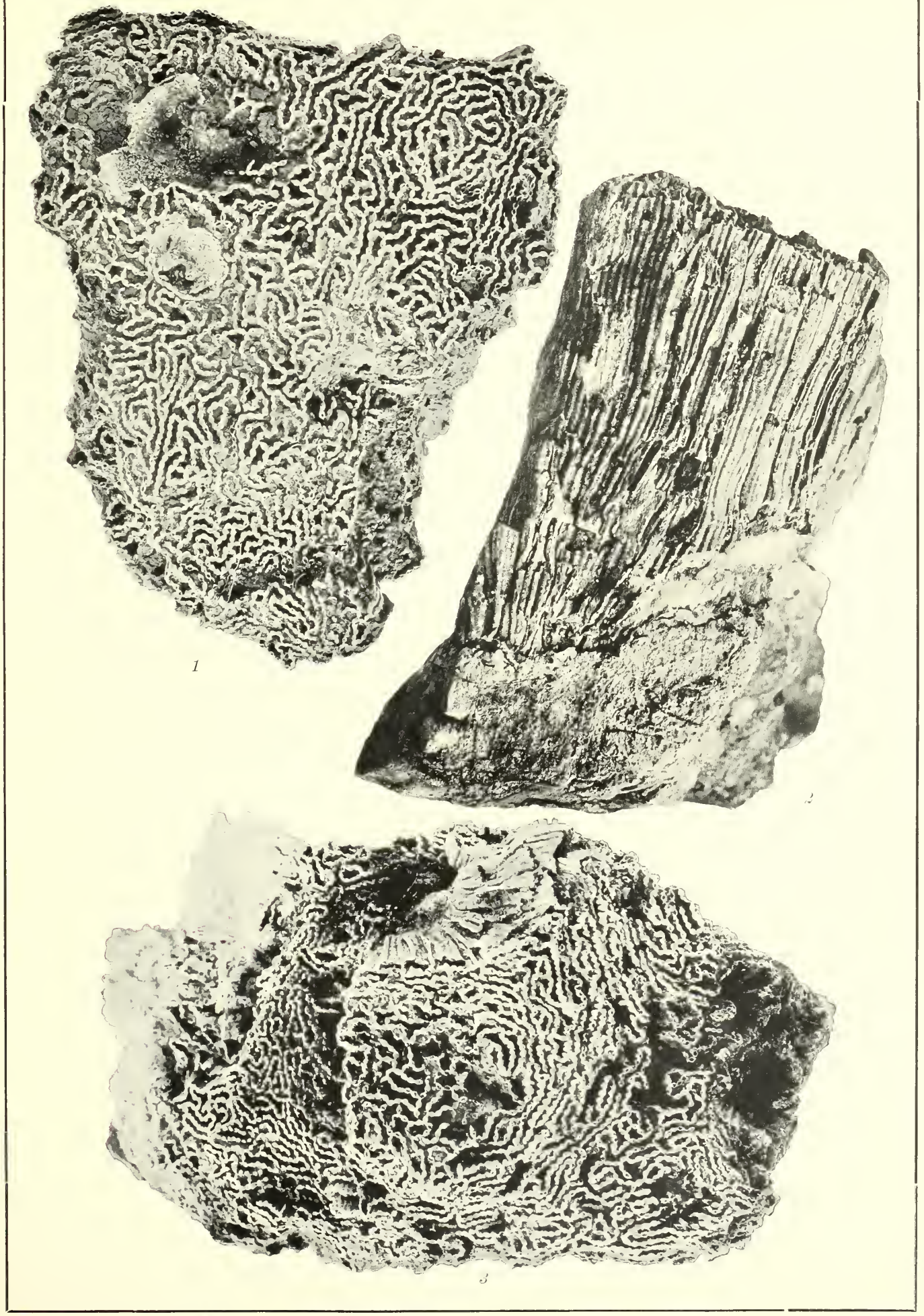
PLATE II.

Halysites peristephesicus, *Eth. fil.*

Fig. 1. Corallum seen from above, exhibiting the long, clustered, and labyrinthine fenestrules and corallite chains, more or less revolving around given centres.

Fig. 2. Portion of a corallum, longitudinal aspect, exhibiting the long corallites, and uneven base of the former.

Fig. 3. Another corallum, seen from above, exhibiting the apparent revolution of the corallite chains in a more marked manner than in Fig. 1.



1

2

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H. Barnes, Junr., photo., Austr. Mus.

PLATE III.

Halysites orthopteroides, *Eth. fil.*

Fig. 1. Corallum seen in longitudinal aspect, exhibiting the long corallites and large fenestrules.

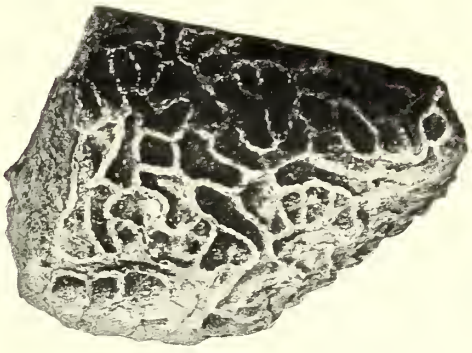
Fig. 2. Corallum seen from above, exhibiting long corallite chains and large fenestrules.

Halysites Sussmilchi, *Eth. fil.*

Fig. 3. Corallum seen in longitudinal aspect, exhibiting the large size and highly fareimentiform outline of the autopores, and hence the corrugated surface of the fenestrule laminæ.

Fig. 4. The corallum seen from above displaying similar characters.

1



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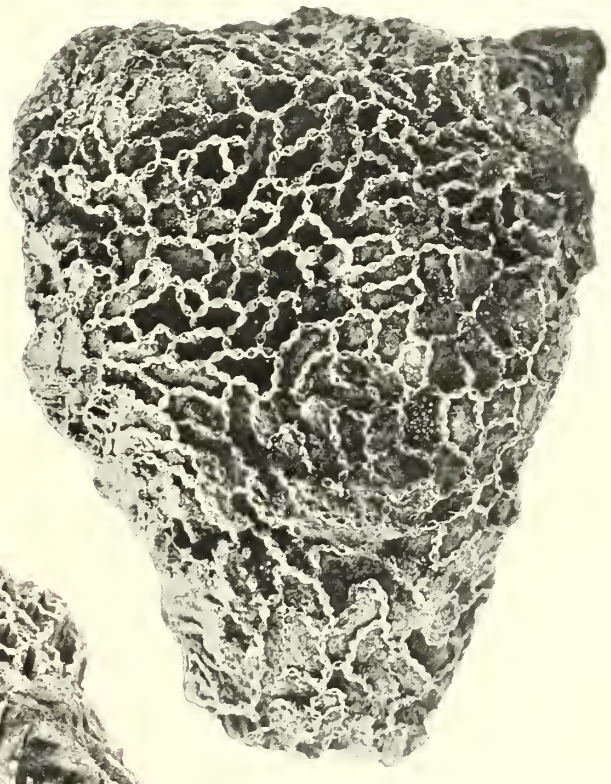

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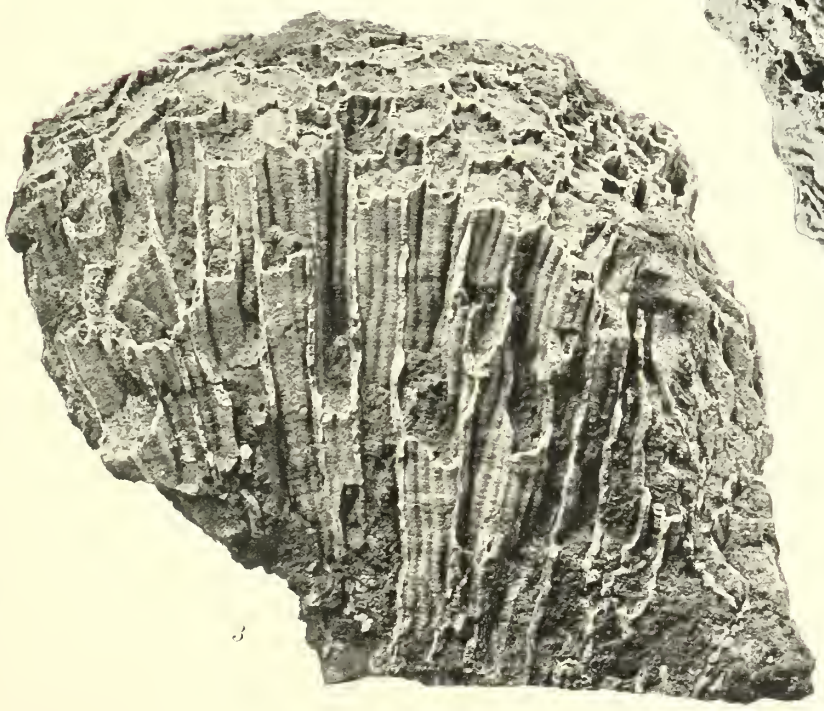


3

H. Barnes, Junr., photo., Austr. Mus.

PLATE IV.

Halysites pycnoblastoides, *Eth. fil.*

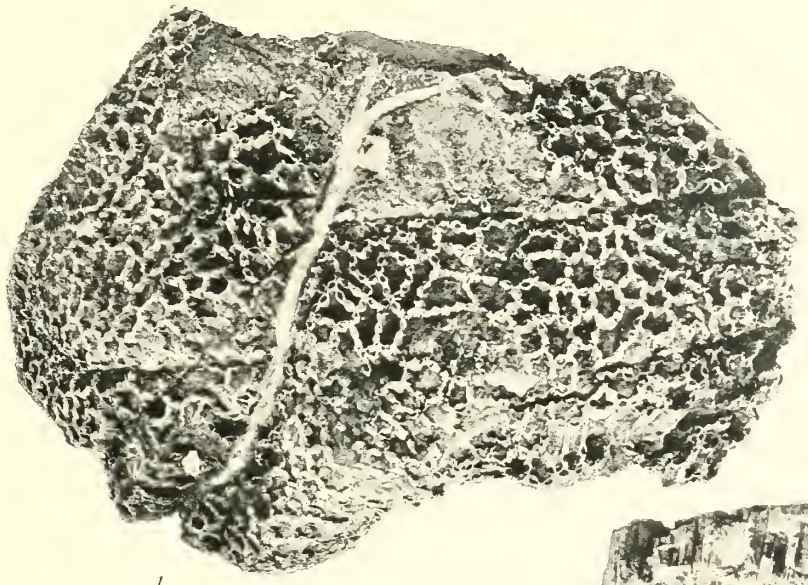
Fig. 1. Corallum seen from above, exhibiting the highly farcimentiform outline of the corallite chains, and gemmuliferous appearance of the autopores, and limited number of the latter in any given chain.

Fig. 2. Corallum seen in longitudinal aspect.

Halysites cratus, *Eth. fil.*

Fig. 3. An irregularly grown corallum, seen from above, with very large fenestrules.

Fig. 4. Corallum seen from above, exhibiting labyrinthine and somewhat crowded fenestrules, highly farcimentiform corallite chains, and large autopores.



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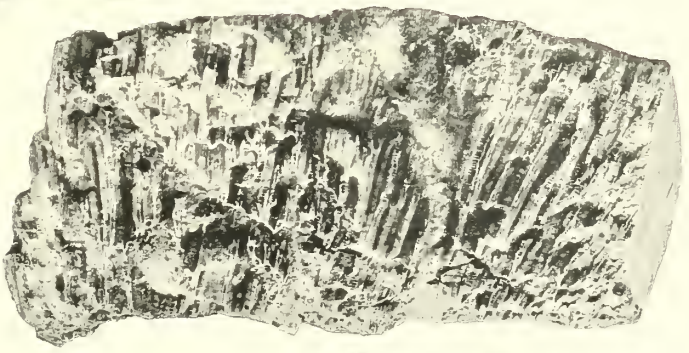

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3

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H. Barnes, Junr., photo., Austr. Mus.

PLATE V.

Halysites gamboolicus, *Eth. fil.*

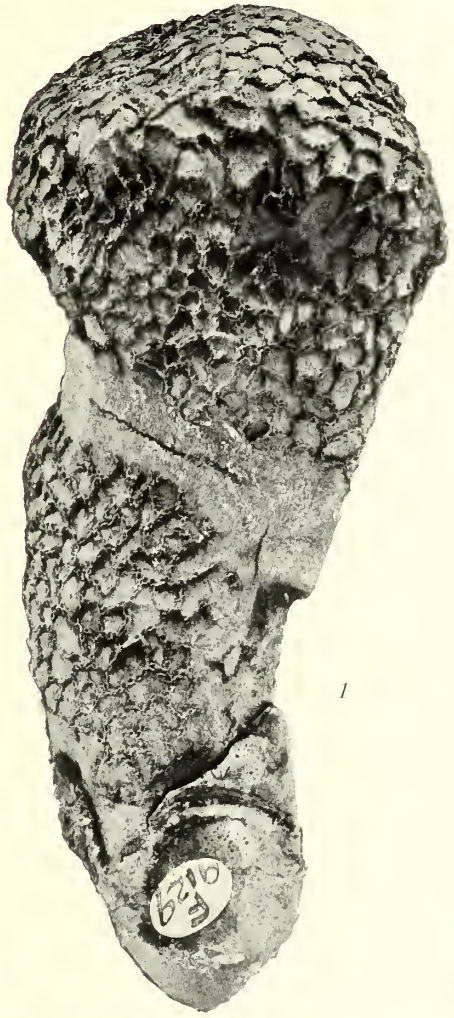
Fig. 1. Pyriform corallum seen from above, exhibiting the dissimilar form of the fenestrules, and small autopores.

Fig. 2. Sub-hemispherical corallum seen from above obliquely.

Halysites chillagoensis, *Eth. fil.*

Fig. 3. Portion of a corallum seen from above.

Fig. 4. Portion of a corallum viewed longitudinally, and to some extent from above also.



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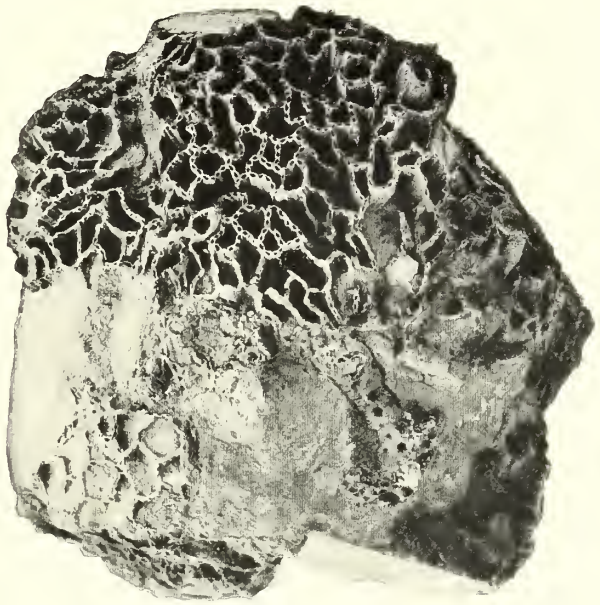

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H. Barnes, Junr., photo., Austr. Mus.

PLATE VI.

Halysites lithostrotonoides, *Eth. fil.*

Fig. 1. Transverse section exhibiting the form of the fenestrules; an incomplete chain; long regular autopores with narrow mesopores between them, and polygonal gonopores.—x 10.

Fig. 2. Longitudinal section showing the visceral chambers and tabulæ of autopores and mesopores, and those of a gonopore. The tube on the extreme upper right is a gonopore.—x 9.

Halysites gamboolicus, *Eth. fil.*

Fig 3. Transverse section exhibiting the form of the fenestrules; length of the corallite chains; long-oval autopores with thick walls, and septal-spines; transversely elongate mesopores, and polygonal gonopores.—x 9.

Halysites australis, *Eth. fil.*

Fig. 4. Longitudinal section exhibiting the autopores with numerous cut septal spines, and narrow pipe-like mesopores.—x 8. The specimen from which this section is prepared is in a highly altered condition; a far better illustration will be found in Pl. VII, Fig. 6.

Halysites eratus, *Eth. fil.*

Fig. 5. Transverse section showing the labyrinthine fenestrules; strongly farcimentiform corallite chains; large oval autopores; and large mesopores in marked re-entrant spaces.—x 8.

Fig. 6. Longitudinal section exhibiting the visceral chambers and regular horizontal tabulæ of the autopores; distant tabulæ of the mesopores, and those of a gonopore on the extreme right, between two autcpores.—x 8.

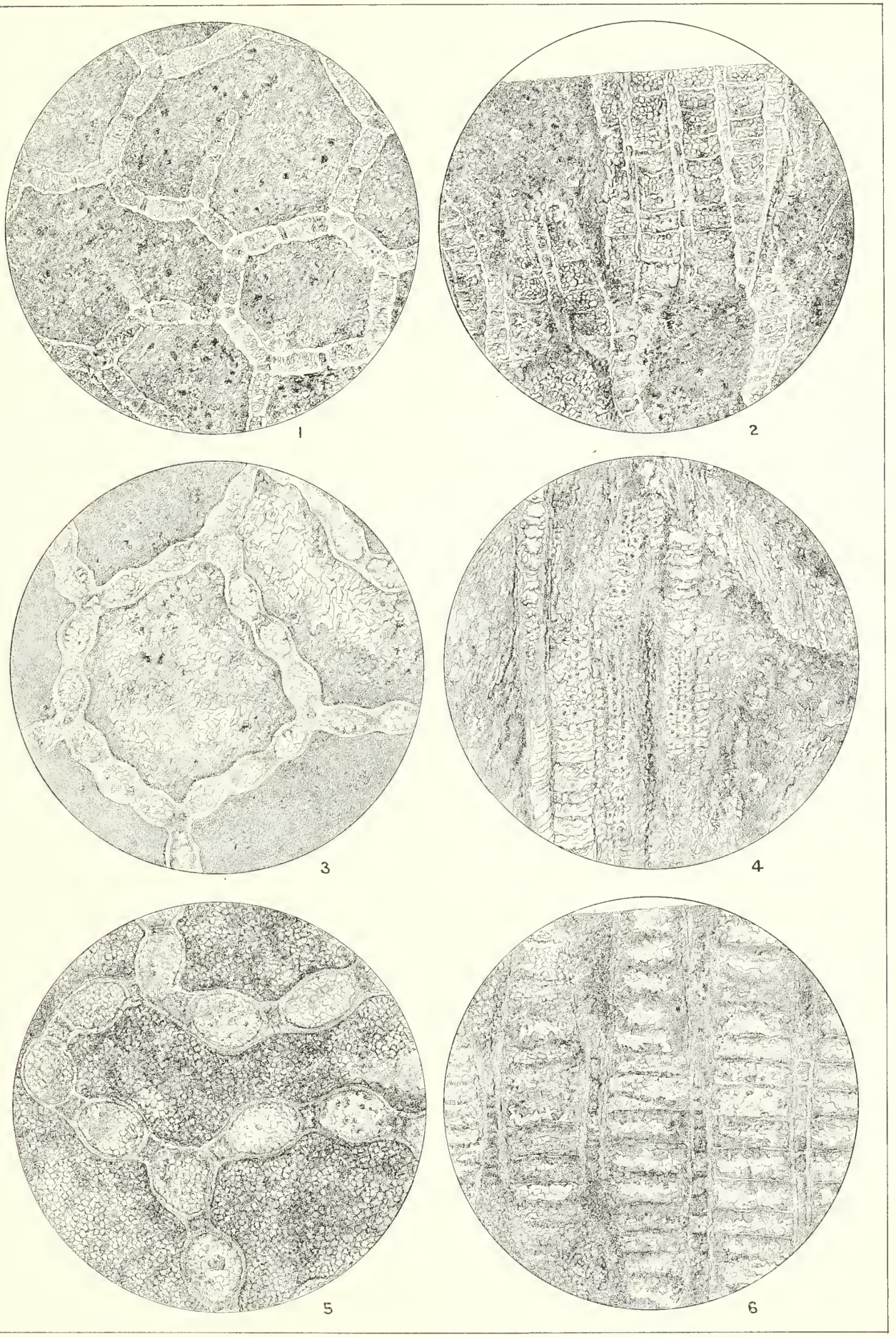

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PLATE VII.

Halysites Sussmilchi, *Eth. fil.*

Fig. 1. Transverse section showing the fenestrules with strongly undulate margins, and highly farcimentiform corallite chains ; round-oval autopores ; mesopores in long re-entrant spaces ; and large polygonal gonopores.—x 7.

Fig. 2. Another transverse section, with imperfectly formed fenestrules, and disunited and new corallite chains.—x 8.

Fig. 3. Longitudinal section, displaying the autopores with low wide visceral chambers and more or less horizontal tabulæ ; a mesopore at the left centre, and a gonopore at the right centre.—x 8.

Halysites orthopteroides, *Eth. fil.*

Fig. 4. Transverse section showing the labyrinthine fenestrules ; slightly undulate margins of the corallite chains ; long oval autopores, separated by mere slit-like mesopores placed in very shallow re-entrant spaces.—x 8.

Fig. 5. Longitudinal section displaying the wide autopores, with their concave tabulæ ; and narrow pipe-like mesopores. On the extreme upper right-hand is a gonopore wedged between two autopores.—x 8.

Halysites australis, *Eth. fil.*

Fig. 6. Longitudinal section exhibiting wide autopores with numerous cut-ends of septal spines ; and narrow pipe-like mesopores with distant tabulæ.—x 8.

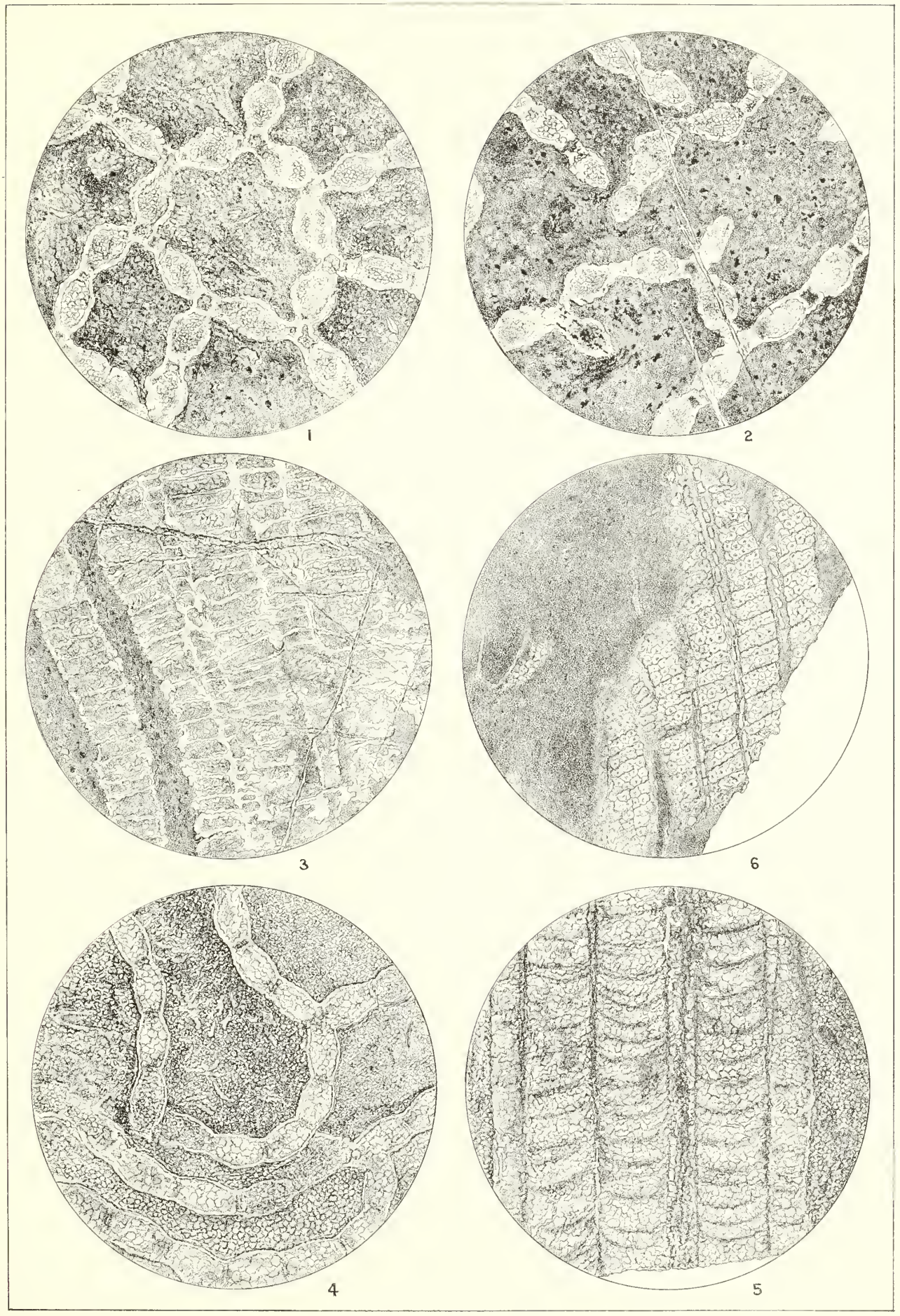

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PLATE VIII.

Halysites peristephesicus, *Eth. fil.*

Fig. 1. Transverse section showing labyrinthine linear fenestrules, with highly undulate margins of the corallite chains; large broad-oval autopores with septa and bulging sides, separated by transversely oblong mesopores placed in deep re-entrant spaces.—x 9.

Fig. 2. Longitudinal section displaying the moderately wide autopores with regular distant tabulæ.—x 9.

Halysites chillagoensis, *Eth. fil.*

Fig. 3. Section of a corallum, cut both transversely and somewhat obliquely, in a poor state of preservation, but exhibiting the less rambling form of the fenestrules, the form of the autopores, and absence of mesopores.—x 8.

Fig. 4. Longitudinal section displaying tabulæ in the autopores.—x 10.

Halysites pycnoblastoides, *Eth. fil.*

Fig. 5. Transverse section displaying strongly farcimentiform corallite chains; oval or nearly round septate autopores; large and irregular gonopores; and large transversely elongate mesopores.—x 8.

Fig. 9. Longitudinal section exhibiting wide and regularly tabulate autopores, with two cycles of septa in each visceral chamber, and a non-septate gonopore between two autopores.—x 8.

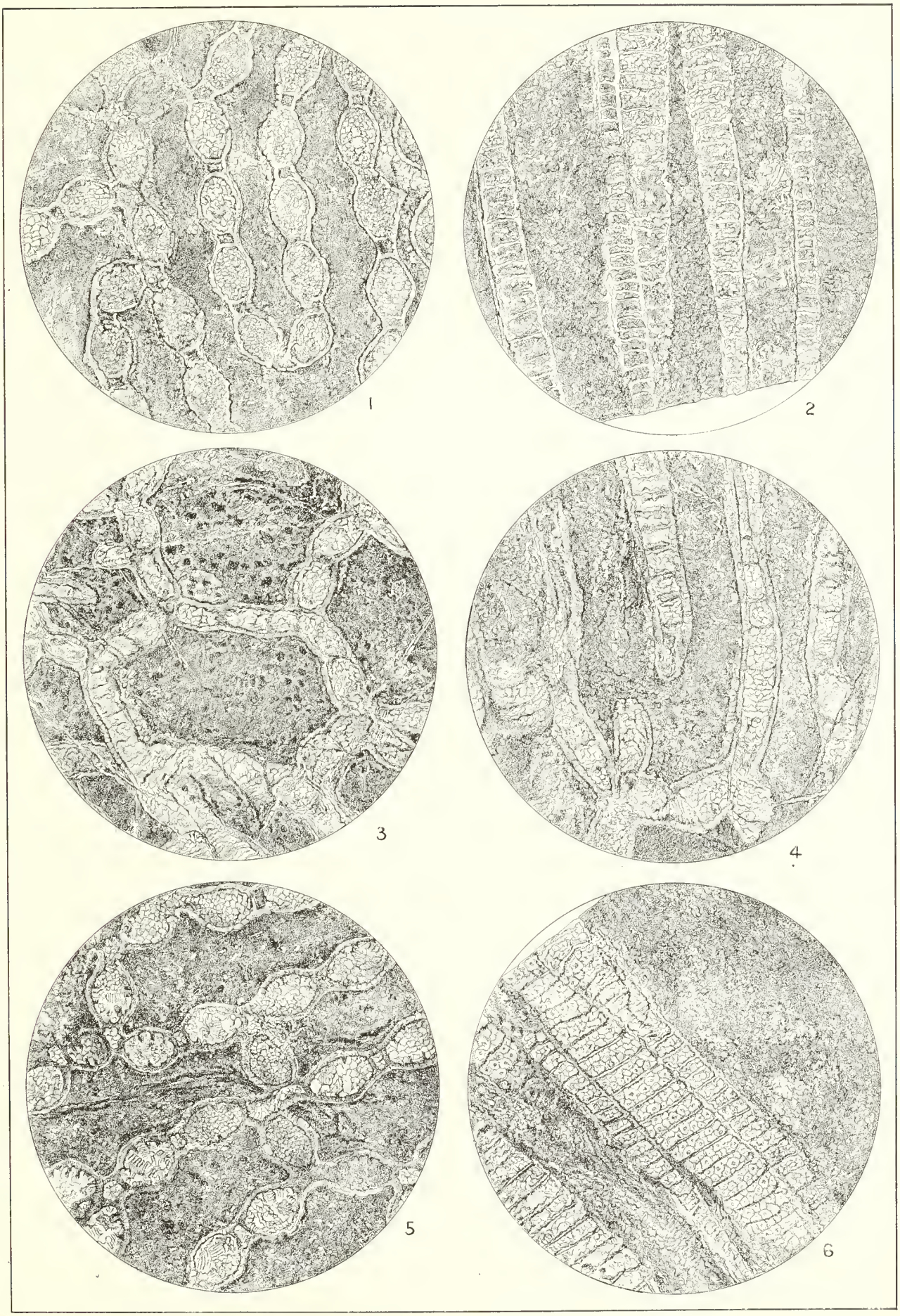

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PLATE IX.

Halysites australis, *Eth. fil.*

Fig. 1. Transverse section with a pentagonal fenestrule; slightly undulated corallite chains; immersed appearance of the long-oval septate autopores, and well-marked mesopores.—x 8.

Fig. 2. Transverse section of a fragment showing a peculiar form of cellular growth occupying a fenestrule.—x 8.

Halysites chillagoensis, *Eth. fil.*

Fig. 3. Portion of a naturally weathered specimen.—x $\frac{1}{4}$.

Halysites lithostrotonoides, *Eth. fil.*

Fig. 4. Portion of a naturally weathered corallum exhibiting a fenestrule partially bisected by an incomplete corallite chain.—x 8.

Halysites sp.

(? H. labyrinthica, *Goldf.*, and H. cavernosa, *F.-B.*)

Fig. 5. Transverse section exhibiting very large round autopores, and cellular mesopores; the corallite chains are highly farcimentiform.—x 8.

Fig. 6. Longitudinal section displaying the very large autopores, with both complete and incomplete tabulæ; and the mesopores with arched tabulæ.—x 8.

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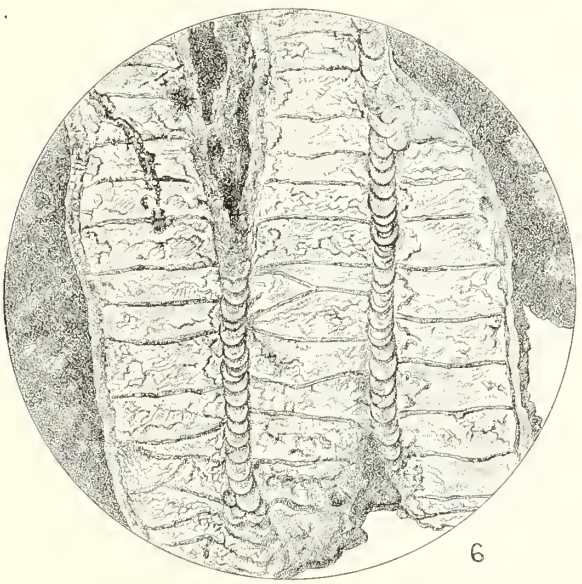
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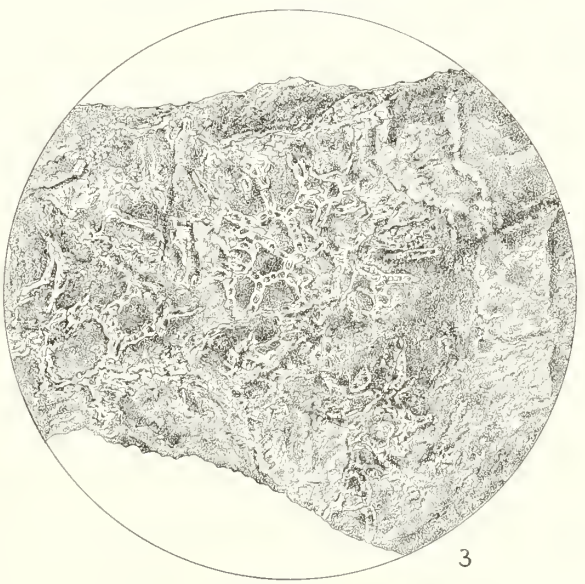
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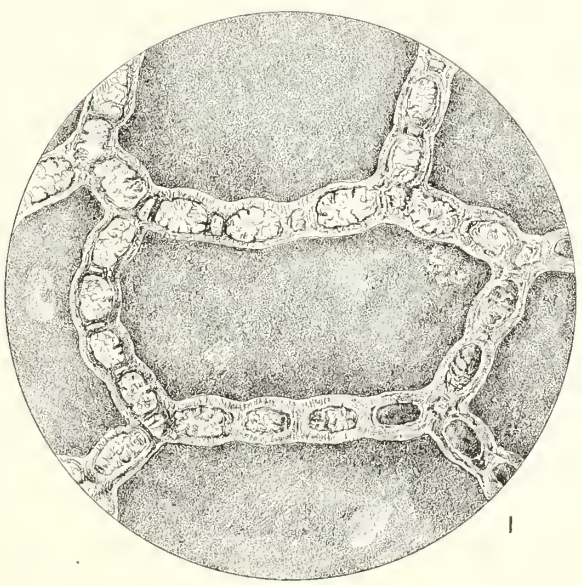
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E. F. PITTMAN, A.R.S.M., UNDER SECRETARY AND GOVERNMENT GEOLOGIST.

PALÆONTOLOGY, No. 13.

A MONOGRAPH

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SILURIAN AND DEVONIAN CORALS OF NEW SOUTH WALES:

WITH

ILLUSTRATIONS FROM OTHER PARTS OF AUSTRALIA.

PART II.—THE GENUS TRYPLASMA.

BY

R. ETHERIDGE, JUNR., J.P.,
CURATOR OF THE AUSTRALIAN MUSEUM, SYDNEY.

ISSUED BY DIRECTION OF THE HON. S. W. MOORE, M.P., MINISTER FOR MINES AND AGRICULTURE.

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June 13, 1908
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Letter of Transmittal.

Geological Survey Branch,
Department of Mines and Agriculture,
Sydney, 12th December, 1906.

Sir,

I have the honour to submit for publication Part II of Memoir No. 13 (Palæontological Series) on the *Silurian and Devonian Corals of New South Wales*, by Mr. Robert Etheridge, Junior, Curator of the Australian Museum.

This volume, on the genus Tryplasma, forms the second contribution by Mr. Etheridge towards the description and classification of the fossil corals which characterise the Upper Silurian and the so-called Siluro-Devonian passage beds, particularly along the Murrumbidgee River, in the neighbourhood of Yass.

Mr. Etheridge's work is of special interest in view of the importance of establishing a dividing line between the Silurian and Devonian rocks of New South Wales.

I have the honour to be,
Sir,
Your obedient servant,
EDWARD F. PITTMAN,
Government Geologist.

The Honourable S. W. Moore, M.P.,
Minister for Mines and Agriculture.

Author's Preface.

The material employed in the present number of the "Monograph of the Silurian and Devonian Corals of New South Wales," forming Part II of that work, and comprising the genus *Tryplasma*, is derived chiefly from the collections of the Australian Museum, and the Mining and Geological Museum, attached to the Department of Mines, Sydney. Specimens in the cabinets of the Geological Department, University of Sydney, and the Geological Class-room at the Technical College, Ultimo, have also been made use of.

The specimens in the Mining and Geological Museum and the Australian Museum we owe mainly to the untiring efforts of Mr. Charles Cullen, late Collector to the Geological Survey, and Mr. A. J. Shearsby, late of the Australian Joint Stock Banking Company, at Yass, respectively, and were placed at my disposal by Mr. E. F. Pittman, A.R.S.M., Under Secretary for Mines and Agriculture, on the one hand, and the Trustees of the Australian Museum on the other. The University corals were chiefly collected by the late Mr. Charles Jenkins, L.S., of Yass, and my thanks are tendered to Prof. T. W. E. David, B.A., for the use of them, and to Mr. C. A. Süssmilch, Lecturer on Geology, Technical College, for the loan of those in his teaching collection, collected by himself.

As in all my work of late years, I have been cordially assisted by Mr. W. S. Dun, Palæontologist to the Geological Survey.

R. ETHERIDGE, Junr.

Sydney, May, 1906.

I.—INTRODUCTION.

Three species, referable to the genus *Tryplasma*, Lonsdale, as I understand it, have, so far, been described from Australian material, all from Upper Silurian strata. The first, *T. Lonsdalei*, mihi, may be regarded as the Australian type, and represents the fasciculate forms; the second, *T. wellingtonensis*, mihi, represents the turbinate-conical species, and the third, *T.* (?) *Murrayi*, mihi, again appertains, more or less, to the fasciculate division. The first two occur in New South Wales and the third in Victoria.

At the inception of my study of this remarkable genus, I had no conception of the wealth of material available, nor of the protean character of the species comprising it. *Tryplasma* is one of the most important genera met with in our Silurian rocks, several of its species indicating well defined stratigraphical horizons, just as the late Dr. G. Lindström has noted in the case of the occurrence of his *T.* (*Pholidophyllum*) *tubulatum* in the Gotland Limestone. The occurrence of *Tryplasma* in Australia, so far as its stratigraphical distribution is at present known, always indicates rocks of Upper Silurian age. At any rate only one doubtful instance to the contrary is known, although in Germany, where it has been recognised under the names of *Calophyllum* and *Cœlophyllum*, it passes into the Stringocephalus Limestone of the Middle Devonian. The importance of *Tryplasma* as a stratigraphical factor will be readily understood when its occurrence at no less than forty-six different localities is pointed out. It is also a world-wide form, the geographical distribution having been indicated by Lindström under the name of *Pholidophyllum*.

II.—HISTORY OF THE GENUS TRYPLASMA.

The history of *Tryplasma* is a peculiar one and must be studied in detail to ensure a proper understanding of the following remarks:—

1845.—We owe the name to Mr. W. Lonsdale,[1] who employed it for a coral from the Silurian rocks of the Ural Mountains, and regarded it as a sub-genus of *Cyathophyllum*. The only species described was *T. æquabilis*,[2] but in a foot-note to his description the author included also *Cyathophyllum articulatum*, Wahl., or a coral he took to be this form. In the explanation of his plate he wrote as follows:—"The coral, believed to be the *Cyathophyllum articulatum* of M. Hisinger, is given to prove that the peculiar characters exhibited by *Tryplasma æquabilis* occur in another coral with a sufficient amount of a differential structure to warrant the establishing of a second species, and, therefore, the proposing of the sub-genus.[3]

The type, *T. æquabilis*, is a cylindrical, solitary coral, with a thin outer wall, a broad central, tabulate area, an outer narrow septal zone, the septal lamellæ numerous, alternately larger and smaller, and round "foramina"; the tabulæ were conceived to be continuous through the septal lamellæ to the outer wall. This is practically Lonsdale's definition, although not exactly in his words. The figure[4] of the supposed *C. articulatum* displays a similar structure to that of *T. æquabilis*, and in addition, being a compound form, the corallites united by connecting bars [fistulæ], rendering the corallum more or less fasciculate.

A thorough conception of the meaning of Lonsdale's "foramina" is essential to a true understanding of the structure of *Tryplasma*. He said: "The peculiarities consist,—first, in the lamellæ [septal lamellæ][5] of the outer area being pierced, from the inner surface of the wall, through their whole breadth by well defined relatively larger foramina, terminating on the inner edge [free inner border of the septal lamellæ] in a distinct row of short tubuli; and, secondly, in the total absence of interstitial vesicular laminæ

[1] Lonsdale—Murchison's Geol. Russia in Europe, 1845, I, p. 613,

[2] Lonsdale—*Loc. cit.*, t. A, f. 7, 7*a*.

[3] Lonsdale—*Loc. cit.*, p. 653.

[4] Lonsdale—*Loc. cit.*, t. A, f. 8, 8*a*.

[5] The words within square brackets are mine.

[dissepimental tissue] at every period of growth." Lonsdale further added that the "diaphragms" [tabulæ] were simply continued between, and possibly through, the "lamellæ" [septal lamellæ] to the outer wall, the extension of the lamellæ inwards being limited. That is to say, Lonsdale conceived a Rugose coral, in which the septa were pierced by pores running transversely through their substance, the pores in question terminating on the inner face edges of these lamellæ in short tubuli. Had Lonsdale grasped the fact that he was examining a mould, or natural intaglio, instead of a natural cameo, he would not have fallen into the error he did, through a misreading of the structural details before him, which, when viewed in this light, are of actual generic value.

Some years ago, when describing the first Australian species of *Tryplasma*, I offered an explanation of the apparent discrepancy in Lonsdale's specimens.[1] The "pores" are not only visible on entirely or partially decorticated specimens, *i.e.*, on those in which the proper wall and septal zone are wholly or in part removed, but also on internal casts, pure and simple. Now, bearing in mind that the septal apparatus consists, first, of narrow, vertical lamellæ, and secondly, of free spines protruding inwards from the free edges of the latter, it naturally follows that on disintegration or partial disintegration of these tissues taking place, grooves running vertically are left, bearing at regular intervals pores or small round openings, the grooves representing the septal lamellæ [lamellæ of Lonsdale], the pores his "foramina," and their extension inwards his "tubuli"; an examination of many of the figures on the accompanying plates will exemplify this far better than a lengthy explanation. In other words, Lonsdale did not endeavour to reconstruct in his mind's eye his imperfect specimen of *T. æquabilis*. Had he done so, he would not have afforded Lindström an excuse for shelving his generic name.

1852.—In their great work "Monographie des Polypiers Fossiles des Terrains Palæozoïques," Messrs. H. Milne-Edwards and Jules Haime wrote of *Tryplasma*[2]:—"If this peculiarity.[the piercing of the septal lamellæ by pores, &c.] really exists, it will assuredly be quite sufficient to distinguish this genus of Cyathophyllidæ from all the other forms of the same group; but we are led to believe that Mr. Lonsdale, when he established the division, was deceived by an appearance, and we have not seen anything similar in one

[1] Etheridge—Rec. Geol. Survey N. S. Wales, 1890, II, Pt. 1, p. 17.

[2] H. Milne-Edwards and J. Haime—Archiv. Mus. Hist. Nat., 1852, V, p. 393.

of the species which he mentioned and named *Tryplasma articulata*." The authors further refer *T. articulata*, Lonsdale, to their *Cyathophyllum* (?) *Loreni*[1], describing the septal lamellæ as larger and smaller alternately, close, thick, and with very close, strong teeth [septal spines], the primary septa corresponding to the intercostal grooves, and the secondary to the costæ.

1854.—Messrs. H. Milne-Edwards and J. Haime used similar language in describing *C. Loveni* in their second work.[2]

1856–1857.—In 1856 the Chevalier E. d'Eichwald, in his "Geographical Distribution of Russian Fossil Remains,"[3] and, in 1857, Dr. von Grünewaldt in a list of the Silurian fossils of the Ural,[4] record *Tryplasma æquabilis*, Lonsdale, but without further remarks other than the localities.

1856.—The Brothers Sandberger described two species of *Amplexus* from the Stringocephalus Limestone of Nassau—*A. tortuosus*, Phillips,[5] and *A. stigmatophorus*, Sandb.[6] As to the first of these, no definite opinion can be passed, but no doubt need exist as to the nature of the second; the longitudinal view of the corallum, that of a weathered specimen, most unquestionably displays the perforations left by the dissolved-away septal spines.

1858–1861.—Mr. E. de Fromental followed Edwards and Haime in uniting *Tryplasma articulata*, Lonsdale, with *Cyathophyllum Loveni*, Ed. and H.[7]

1861.—The Chevalier E. d'Eichwald, rather more cautious than Edwards and Haime, refers[8] to *Tryplasma* [*Trypelasma* he spelt it], as "perhaps" referrable to *Cyathophyllum*. He further described a coral from the Silurian rocks of the island of Oesel as *Omphyma fastigiatum*[9] which Lindström subsequently included in his *Pholidophyllum tubulatum*. The septal spines, anchoring rootlets [radiciform processes], and calicinal budding figured by d'Eichwald at once denote its relation to *Tryplasma*.

---

[1] H. Milne-Edwards and J. Haime—*Loc. cit.*, p. 304.

[2] H. Milne-Edwards and J. Haime—Mon. Brit. Foss. Corals, Pt. 5, 1854, p. 281, t. 66, f. 22*a*.

[3] Eichwald—Bull. Soc. Imp. Nat. Moscou, 1856, No. 1 (1857), p. 110.

[4] Grünewaldt—Notizen Versteinerungführenden Gebirgsform. Ural, 1857, p. 23.

[5] Sandberger—Verstein. Rhein. Schichten. Nassau, Lief. 9, 1856, p. 413, t. 37, f. 5, 5*a* and *b*.

[6] Sandberger—*Ibid.*, p. 413, t. 36, f 14*a* and *b*. Both of Sandberger's species are referred by Frech to *Amplexus hercynicus*, A. Roemer.

[7] Fromantal—Introd. Étude Polyp. Foss., 1858-61, p. 295.

[8] Eichwald—Lethæa Rossica, 1861 (?), I, Pt. 2, p. 544.

[9] Eichwald—Lethæa Rossica, 1861 (?), I, Pt. 2, p. 547, t. 29, f. 11, *a-c*.

1865–6.—In his very remarkable paper on the "Corals of the Palæozoic Formations," Mr. Rudolph Ludwig described and figured a small coral as *Acanthoconium inversum*,[1] which presents all the typical septal features of a turbinate form of *Tryplasma*. His very interesting figures re-illustrate, in a great measure, the very condition of preservation originally described by Lonsdale, *i.e.*, an internal cast in which the longitudinal lines of the primary and secondary septal spines are represented by tube-holes penetrating the matrix; the accuracy of his diagrammatic figure of the septal system is, however, open to question. At a later stage, in the same paper, the Author describes the cylindrical form, afterwards termed *Pholidophyllum tubulatum* by Lindström, as *Tæniocyathus* or *Tæniolopas spinosa*,[2] which is an excellent representation of a cylindrical *Tryplasma*—form, budding, septal-lamellæ with spines, and tabulæ. At least two species of Mr. Rudolph Ludwig's genus *Ptychocyathus*,[3] viz., *P. profundus* and *P. granulifer*, are referable to *Tryplasma*. The pore-like holes left by the dissolved-away septal spines are visible in the figures of both, and in the enlargement (Fig. 1*e*) of a portion of the weathered surface of *P. profundus* both the primary and secondary rows of septal spines are excellently represented.

1870.—In this year Dr. G. Lindström[4] proposed his genus *Pholidophyllum*, selecting as the type *Cyathophyllum Loveni*, M. Edw. and Haime, remarking—"Its strange exothecal covering in scaly rows, its septa, its well-developed tabulæ, its double costæ, and the complete want of dissepimental structure between the septa, justify my forming a new genus out of it, which I propose to name *Pholidophyllum*."

1873.—The genus *Acanthodes* was next proposed by Dr. W. N. Dybowski[5] for the reception of several Silurian species, either simple or sub-fasciculate, provided with anchoring rootlets on the underside of the corallites, and narrow lamellar septa of two orders produced into spines along their free edges. The tabulæ are variously formed, occupying the whole of the visceral space, but not reaching the wall, says Dybowski—a manifest error, although it will be remembered Lonsdale made the same remark; no allusion is made to the presence of either a fossula, dissepiments, or exothecal scales. Reproduction was observed only in one species (*A. tubulus*), the young corallites occasionally

[1] Ludwig—Palaeontographica, 1865, XIV, 4 Lief., p. 145, t. 32, f. 22*a-e*.
[2] Ludwig—Palaeontographica, 1865, XIV, 5 Lief., pp. 187 and 201, t. 47, f. 3*a-c*, t. 57, f. 4.
[3] Ludwig—Palaeontographica, 1866, XIV, 5 Lief., p. 196, t. 49, f. 1, 1*a-c*; p. 196, t. 49, f. 4.
[4] Lindström—Öfvers. Vet. Akad. Forhandl., 1870, p. 925, f. n; Geol. Mag., 1871, VIII, p. 125, f. n.
[5] Dybowski—Mon. Zoantharia Scler. Rugosa, Pt. 1, 1873, p. 108.

budding from the sides of the parent stem[1]—lateral or parietal gemmation in other words. From what has already been said of the true structure of *Tryplasma*, it will be at once apparent that, with the exception of the parietal gemmation, that of *Acanthodes* is identical with the former, as was first pointed out by Dr. Lindström.

Dybowski also resuscitated Dana's genus *Calophyllum*[2] for other corals from the same area, consisting of simple and conical, or aggregated corallites, with septal lamellæ of two orders, the secondary granular. Tabulæ of various forms occupy the whole breadth of the visceral cavity. Dybowski regarded these corals as intermediate between *Cyathophylloides* and *Amplexus*. It is possible that the first species described may be a *Tryplasma*, although he mentions the presence of lateral buds, and one is shown in the species referred to (*C. Roemeri*).[3]

1873.—Two species were referred by Professor F. H. E. Kayser to *Amplexus* that have every appearance of *Tryplasma*, viz. *A. tortuosa*, Phill.,[4] and *A. irregularis*, Kayser,[5] are from the German Devonian. In the former, delicate septa [? septal spines] are shown in a transverse view of the corallum, with distant horizontal tabulæ, and a fistula in the longitudinal view. In the latter, similar septa, and vesicular tabulæ, the vesicles closely resembling those of several of our N. S. Wales corals. Nothing of a decisive nature can be gleaned from Phillips' description and figure of *A. tortuosa*.[6]

1876.—Amongst his synonyms of *Pholidophyllum tubulatum*, Lindström included *Cyathophyllum radicula*, Rominger, a coral from the Niagara Group of North America. Rominger says[7] the cylindrical corallites are strongly attached by their bases to other bodies, and strengthened by anchoring [radiciform] processes. There are "about" sixty alternately larger and smaller crenulated septal lamellæ, which either extend to the centre of the bottom of the calice formed by the uppermost tabula, or the latter is smooth, or again faintly carinate or granulate. The reference of *Cyathophyllum radicula* to *Tryplasma* is hardly warranted by the description, more particularly as the presence of a septal fossula is foreshadowed, or in Rominger's words "a septal fovea is rarely indicated."

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[1] Dybowski—*Ibid.* p. 114, t. 1, f. 13*b*.
[2] Dybowski—*Ibid.* p. 118.
[3] Dybowski—*Ibid.* t. 2, f. 3.
[4] Kayser—Zeitsch. Deuts. Geol. Gesellsch., 1873, XXIV, p. 685, t. 27, f. 5*a–c*. This is referred by Frech to *A. hercynicus*, A. Roemer.
[5] Kayser—*Ibid.* p. 691, t. 27, f. 7*a–d*.
[6] Phillips—Pal. Foss. Cornwall, Devon, &c., 1841, p. 8, t. 3, f. 8*a* and *b*.
[7] Rominger—Geol. Survey Michigan—Lower Peninsula, 1873–76, III, Pt. 2, 1876, p. 109, t. 39, f. 3.

1881.—Dr. Georg Meyer, in a paper on the "Rugose Corals of the East and West Prussian Diluvial Formation," adopted Dybowski's name of *Acanthodes*, placing *Tryplasma* as a synonym under it; one species was described, *A. borussicus*, Meyer.[1] Notwithstanding Dr. Meyer's involved description, this is clearly a species of *Tryplasma*. The illustrations display the typical spined septal lamellæ, wide central tabulate area, and the absence of dissepiments.

1881.—Dr. Clemens Schlüter, like Dybowski, employed Dana's dubious name *Calophyllum*. He described a coral from the Stringocephalus Limestone as *C. paucitabulatum*.[2] The corallum is more or less fasciculate, consisting of elongately conical, or almost cylindrical corallites, sometimes united to one another by fistulæ. The septa are quite rudimentary, but still of two orders, the tabulæ horizontal and very widely separated apart; there are neither dissepiments, nor fossula. Reproduction is effected by profuse calicinal budding, from three to six buds, having one-half of their walls at first in common with the parent calice. As to the presence of a fossula, Dr. F. Frech[3] believed he could detect such a depression in a specimen of *C. paucitabulatum* examined by him; but Schlüter subsequently controverted this.[4] The latter considered his species to differ from *Amplexus* in the absence of this fossula, distance apart of the tabulæ, and the mode of reproduction. This coral bears a most remarkable resemblance to some of our *Tryplasmæ*, a resemblance borne out by the fact that later writers described the narrow septal lamellæ as spined; this will be again referred to later.

1882.—In his more extended and valuable paper on the "Palæozoic Operculate Corals," Dr. G. Lindström wrote as follows[5]:—"It is fitting to mention also two others, partly known for a long time, which have been found to possess round the outer walls, and at the edge of the calice, exotheeal structures, to a certain extent homologous with and in all respects comparable to the opercula of the former [*Calceola*, *Goniophyllum*, *Rhizophyllum*, &c.]. The most common is that which forms the genus *Pholidophyllum*."

Under *Pholidophyllum*, Lindström placed *Tryplasma*, Lonsdale, and *Acanthodes*, Dybowski, and said the genus "should perhaps have been called *Tryplasma*; but this name having been founded on an error, according to

[1] Meyer—Schriften Physik.-Ökonomis. Gesellsch. Königsberg, 1881, Abth. 1, p. 100, t. 5, f. 3-6*a*.
[2] Schlüter—Verhandl. Natur. Vereines Preuss. Rheinl. Westfalen., 1881, VIII (4), p. 190.
[3] Frech—Dames and Kayser's Pal. Abhandl., 1886, III, Heft 3, p. 100.
[4] Schlüter—Abhandl. Geol. Specialkarte Preuss. Thüring. Staaten, 1889, VIII, Heft 4, p. 9 (267), f.n. 2.
[5] Lindström—Bihang K. Sv. Vet. Akad. Handlingar, 1882, VII, No. 4, p. 63.

which the septal spines and septal lamellæ should be perforated by canals, a supposition caused by the broken lower parts of the spines, I have proposed the new name . . . . based upon the peculiarities of the outer scales" [exotheeal struetures of the preceding paragraph]. Lindström was unquestionably correct in plaeing Dybowski's *Acanthodes* as a synonym, both on aecount of its structure and, as he said, by preoccupation as the name of a fish (*Acanthodes*, L. Agassiz).

On the more important point, however, of the substitution of the name *Pholidophyllum* for that of *Tryplasma*, I formerly wrote as follows[1]:— "I regret that I cannot agree with Dr. Lindström in the abolition of *Tryplasma*. If every generie name in Palæontology is to be abolished because an original misconeeption as regards its strueture was made, few of the older genera would stand. Granting that a genus has been figured and deseribed to the best of an author's knowledge and the material before him, it seems difficult to understand how his work can be set aside. I therefore adopt *Tryplasma* as typified by Lonsdale, and described by Lindström under the name of *Pholidophyllum*, with this exception—I believe that *Palæocyclus* should be eliminated from the latter."

The coral here selected by Lindström as the type of his genus was the *Tubiporites tubulatus*, Schlotheim, and a very full synonomy was given, inclusive of both speeies comprised by Lonsdale in his *Tryplasma*, and also *Cyathophyllum* (?) *Loveni*, previously referred to under Milne-Edwards and Haime and Lindström (1870). This synonymy affords a very complete bibliography of the coral up to the date of publieation of Lindström's paper from his point of view, and will serve to amplify the historical references here given. The corallum in *Pholidophytlum tubulatum* is described as compound, budding in quadruple divisions, but in this "compound" (or, as I would prefer to eall it, "sub-compound") growth Lindström reeognised two conditions in the one species, the "forma primaria" and the "mutatio." The former is broad conical, the latter eylindrieal, either fixed by anehoring rootlets extending from near the distal end of the corallum, or by the whole base; the rootlets are either simply tubular or tabulate. The septal lamellæ are of variable width, and of two orders, forty of eaeh, dentieulated on their free edges, and granulated on the lateral faces; there is no fossula. A wide central tabulate area is left, the tabulæ vertically spined on their upper surfaces. Gemmation is calieular, four new corallites arising within the caliee

[1] Etheridge—Rec. Geol. Survey N. S. Wales, 1890, II, Pt. 1, p. 15.

of the parent, not simultaneously, but in succession, each from its own side and meeting in the middle. The most peculiar feature of *P. tubulatum* is the occurrence of exothecal structures in the form of "numerous curious little scales" on the pseudocostæ or rugæ of the simple forms, arranged longitudinally, and "which generally fall off," each pair of rugæ bearing two rows of scales. These are described in detail by Dr. Lindström, and are compared to the opercular valves of *Aræopoma prismatica*; the scales in question are not found on the compound corallums of *P. tubulatum*. The whole structure of the latter, omitting these exothecal scales from consideration, is precisely that of *Tryplasma*.

1882.—The structure of the coral already referred to as *Cyathophyllum* (?) *Loveni*, or, as it is sometimes spoken of by Authors, *Pholidophyllum Loveni*, has been very fully treated of by Mr. G. von Koch.[1] He confirmed the remarks of Edwards and Haime on the presence of spiniferous septal lamellæ. The tabulæ, and other points of structure, including the gemmation, are strictly those of *Tryplasma* as revealed in Australian specimens. Koch's figures of the budding are very valuable, as they illustrate the gradual appearance of the young corallites from the earliest stage in one and the self-same parent corallite. In this series of five figures we trace the appearance of four buds, each one commencing as a small inwardly convex continuation of the mother wall, gradually enlarging and extending inwards until the whole of the parent calice is filled up.[2] Even more interesting, however, is the extension inwards of the maternal septal spines within the boundary of a bud to become the peripheral septal laminæ and spines of the latter, whilst those springing from the inner wall of the bud are a new creation; these buds are bilaterally symmetrical. A glance at the gemmation of our *T. princeps*, *T. liliiformis*, &c., will at once indicate how close a connection there is between their mode of increase and that of *P. Loveni*.

1883.—In this year Dr. Lindström, in a most useful paper—"Index to the Generic Names applied to the Corals of the Palæozoic Formations,"—again placed *Tryplasma* as a synonym of *Pholidophyllum*.[3]

1883.—In the volume of Richthofen's great work on China, devoted to Palæontology, the same eminent describer of Palæozoic Corals described and figured three species of *Amplexus* of Upper Silurian age, viz., *A. viduus*,

[1] Koch—Palæontographica, XXVIII, 6 Lief, 1882, pp. 216-219.
[2] Koch—*Ibid.* t. 43 (1), f. 18-22.
[3] Lindström—Bihang K. Sv. Vet.-Akad. Handl., 1883, VIII, No. 9, p. 12.

A. distans, and *A. appendiculatus*.[1] Of these, the figures of the second and third exhibit undoubted evidence of *Tryplasma* characters in the presence of spiniform septal lamellæ, thickened walls, and characteristic features of the tabulæ.[2] In the longitudinal section of *A. distans* the septal spines are visible in the intertabular spaces or old visceral chambers; in the horizontal section the thick tooth-like terminations of the septal spines send off delicate linear filaments when a cycle impinges on a tabula in precisely the same manner that the similar organs do in some of our indigenous species. In the horizontal section of *A. appendiculatus* a like feature is observable, whilst in the longitudinal section of the same coral[3] both the septal spines and vesicular tabulæ are visible, the vesicles long and lenticular; radiciform processes are also present.

1883.—The late Prof. Ferdinand von Roemer proposed the name *Cœlophyllum*[4] to take the place of *Calophyllum*, Dana, already referred to, on the ground that it is altogether doubtful what Dana intended to include in his genus. As his type, Roemer selected Schlüter's *Calophyllum paucitabulatum*, and added to its definition the important statement that the radiating lamellæ in his specimens were finely denticulated and delicately notched, thus supporting the otherwise general *Tryplasma*-like appearance of this coral.

1885.—Mr. F. Maurer, in his "Fauna of the Waldgirmer Limestone near Griessen," referred two corals to *Acanthodes*, Dybowski, *A. retinens*,[5] and *A. pastinatus*,[6] but the illustrations do not satisfactorily remind me of Acanthodian characters. Under *Calophyllum* is placed another coral (*C. serratum*[7]) which may be a *Tryplasma*, presenting the sectional transverse appearance of the genus in which the septal lamellæ are united by a thick peripheral zone of stereoplasma, with the characteristic toothed inner free edge.

1891.—In his "Chart of the Rugose Corals," Mr. W. H. Sherzer[8] included in *Pholidophyllum*, Lindström, both *Tryplasma* and *Acanthocyclus*, Dybowski. He also combined with these "*Scarithodes*," Dyb., a name I am quite unacquainted with, unless it is a misprint for *Acanthodes*.

[1] Lindström—Beiträge Pal. China (Richthofen's China, IV), 1883, pp. 62–63.
[2] Lindström—*Ibid.*, t. 6, f. 1 and 5.
[3] Lindström—*Ibid.*, t. 6, f. 7 and 8 (*non* f. 11 and 12).
[4] Roemer—Lethæa Pal., 1883, 2 Lief., p. 409.
[5] Maurer—Abhandl. Gross. Hessischen Geol. Landesanstalt Darmstadt, 1885, I, Heft 2, p. 80, t. 1, f. 5–7.
[6] Maurer—*Ibid.*, p. 82, t. 1, f. 8, 8*a*.
[7] Maurer—*Ibid.*, p 89, t. 1, f. 22, 22*a*.
[8] Sherzer—American Geol., 1891, VII, No. 5, pp. 290-291.

1894.—In a paper on "East-Prussian and Eastern West Prussian Silurian Corals," Mr. W. Weissermel described *Amplexus borussicus*.[1] The corallum is evidently sub-fasciculate, of long, cylindrical, straight or curved corallites, augmenting by gemmation which is doubtfully said to be lateral. Primary and secondary septal laminæ are present, the former spined on their free edges, the latter represented by rows of granules. The tabulæ are regular and complete; dissepiments do not exist, and no mention is made of a fossula. The affinities of this coral are believed by the author to be with *Amplexus*, but, from the clear description and figures, I have little hesitation in pronouncing it to be a *Tryplasma*. Indeed, the author also suggests an affinity with *Pholidophyllum*, but considers the length of the septal spines in his species as a point of distinction. A reference to some of Lindström's figures of *P. tubulatum*[2] will show that this possessed equally long spines.

Weissermel also afforded some interesting particulars about *Cœlophyllum*[3] and *Pholidophyllum*. He regarded the first merely as a sub-genus of *Amplexus*, following Freeh, and described his *C. eurycalyx* as forming "bundle-shaped masses," the corallites varying from between short coniform to long subcylindrical, with bell-mouthed calices and everted margins, diverging from one another; fistulæ are present. The septal lamellæ are more than fifty, and of two orders; the secondary, if I understand the author correctly, are toothed. The tabulæ are complete, horizontal, and closely packed. Copious calicular gemmation takes place; the buds at first "pouch-shaped," then becoming slightly divergent slender cones, and giving to the entire colony a cluster or bundle-like appearance; there are eight buds to a calice.[4] Weissermel very justly draws attention to the close resemblance of the septal apparatus of his coral to that of *Pholidophyllum* and *Polyorophe*, Lindström. He also figures the wide expanding calice, close tabulæ occupying a stem-like corallum, and toothed free edges of some of the septal lamellæ. The resemblance between these structures and those of one of our New South Wales *Tryplasmæ*, particularly those of the calice and stem, is very marked, and will be commented on later.

Weissermel also refers to *Pholidophyllum* a composite coral,[5] composed of bundles of long cylindrical corallites in contact with each other, and

[1] Weissermel.—Zeitsch. Deuts. Geol. Gesellsch., 1894, XLVI, Heft 3, p. 632, t. 50, f. 7 *a* and *b*.

[2] Lindström—Bihang K. Sv. Vet.-Akad. Handl., 1882, VII, No. 4, t. 9, f. 14 and 15.

[3] Weissermel—Zeitsch. Deuts. Geol. Gesell., 1894, XLVI, Heft 3, p. 634, t. 50, f. 8 and 9, t. 51, f. 1.

[4] Weissermel—*Ibid.*, p. 636, f. 1 and 2.

[5] Weissermel—*Ibid.*, p. 638, t. 51, f. 2 *a* and *b*.

increasing by calicular gemmation. He failed to detect any opercular scales, but mentions the two conditions—specific (cone-shaped) and mutatio (cylindrical)—described by Lindström. The peripheral area between the septal lamellæ is filled with stereoplasma of varying thickness, but in some corallites forming a solid zone, which leaves only the spine-like ends of the lamellæ free.

1902.—Mr. N. Lebedew, in his "Devonian Corals of Russia," refers to Lonsdale's type *T. æquabile* as a *Cyathophyllum*,[1] but I regret my inability to read Russian and am not in a position to discuss the matter further.

[1] Lebedew—Mém. Comité Géol. Russ., 1902, XVII, No. 2, p. 87. Lebedew gives references to two other notices of *T. æquabile*, those of Grünewaldt and Hoffman.

III.—RELATION TO OTHER GENERA, AND SYSTEMATIC POSITION OF TRYPLASMA.

The family Palæocyclidæ, instituted by Dybowski,[1] contains several genera of small, simple, discoidal or bowl-shaped corals, some of which, at least, possess lamellar septa crenulated on their free edges and granulated laterally —such, for instance, are *Palæocyclus*, Ed. and H.,[2] and *Acanthocyclus*, Dybowski.[3]

Palæocyclus, according to the late Prof. P. M. Duncan,[4] possesses tabulæ, a fossula, and endothecal tissue [septal dissepiments]. In the presence of the two latter structures it therefore differs from *Tryplasma*. On the other hand, the late Prof. K. Zittel[5] says that throughout the family both tabulæ and dissepiments are wanting. *Acanthocyclus*[6] is described by Dybowski in but very few words, and really does not appear to possess any characters of importance separating it from *Palæocyclus*.

The presence of tabulæ, septal spines, radiciform processes or anchoring rootlets, and fistulæ at once distinguishes *Tryplasma* from the simple corallum of *Petraia*, Munster, as restricted by F. Roemer[7]; indeed, the septal structures are but very feebly developed at all in this genus.

From all the *Amplexus*-like forms, *Tryplasma* is separated by the presence in the latter of septal spines, although in some other points there is a close degree of resemblance. In *Amplexus* the corallites are always simple and solitary,[8] and occasionally hollow radiciform processes are developed. The septal lamellæ are remarkably rudimentary, narrow as in *Tryplasma*, but unlike those of the latter, these lamellæ, in all typical *Amplexi*, are never produced into spines on their inner or free edges; a septal fossula is present, but never in *Tryplasma*, and dissepiments exist in neither. Messrs. J. Thomson and H. A. Nicholson say[9] "there may or may not be interseptal

[1] Dybowski—Zoantharia Scler. Rugosa, Pt. I, 1873, p. 77.

[2] H. Milne-Edwards and Haime—Archiv. Mus. Hist. Nat. Paris, 1852, V, p. 203.

[3] Dybowski—Zoantharia Scler. Rugosa, Pt. I, 1873, pp. 77 and 103.

[4] Duncan—Phil. Trans., CLVII, p. 651.

[5] Zittel—Text Book Pal. (Eastman's Edit.), 1900, I, p. 74.

[6] Dybowski—Zoantharia Scler. Rugosa, Pt. I, 1873, p. 103.

[7] F. Roemer—Lethæa Pal., 1883, I, Lief. 2, p. 410.

[8] H. Milne-Edwards and Haime—Archiv. Mus. Hist. Nat., 1852, V, p. 325; Thomson and Nicholson—Ann. Mag. Nat. Hist., 1875, XVI (4), p. 424; Schlüter—Abhandl. Geol. Specialkarte Preuss. Thuring. Staaten, 1889, VIII, Heft 4, p. 8 (266).

[9] Thomson and Nicholson—Ann. Mag. Nat. Hist., 1875, XVI (4), p. 425.

dissepiments, whilst these, when present, are always comparatively simple and few in number." Dr. Clemens Schlüter has treated this subject at length,[1] and pointed out that sundry corals possessing dissepiments have been referred to *Amplexus, e.g., A. lineatus*, A. Roemer, *A.* (*Campophyllum*) *gigantcus*, Mich., &c., but as dissepiments are not present in the type species *A. coralloides*, J. Sby., their absence may be accepted as a generic character, and the genus must be restricted accordingly; the late Prof. L. G. de Koninck denied[2] the presence of dissepiments in *Amplexus*.

The tabulæ of *Amplexus* proper are exceedingly well developed, complete, either horizontal or oblique, and usually distant from one another, or sub-vesicular, forming a wide, central, usually smooth area on which the septa do not impinge to any great extent, just as we find them in the various species of *Tryplasma*. In other words, the latter, so far as its general structure is concerned, is an *Amplexus* in which the corallum is either simple or sub-fasciculate, the septal laminæ spined, without a fossula, and reproduced almost wholly by calicular gemmation. Even in *Amplexus*, budding is believed, by some Authors,[3] to take place.

The late Mr. James Thomson described[4] the septa as either wanting, or delicate and short, and of one order; a rudimentary fossula is also said to exist, "which is usually formed by a slight lateral depression of the tabulæ." All the species described by Thomson are simple, and are said to be "developed from ova." In two of the species, however, there are these peculiarities:— In *A. Sowerbyi*, Phill., "the septa are indicated by minute pointed granules," and in *A. irregularis*, the secondary septa only are so.

The community of structure between *Acanthodes*, Dybowski, and *Tryplasma* has already been pointed out.

Closely allied to *Amplexus* is *Pycnostylus*, Whiteaves.[5] The latter is said by its describer to differ from the former "only in the circumstance that it grows in colonies of compound and apparently fasciculate corallites."[6] It may also be said to differ, again according to Mr. Whiteaves, in its method of reproduction "by calicular gemmation at distant intervals into sets of three, four, or more ascending, subparallel, contiguous, flexuous branches."

[1] Schlüter—Abhandl. Geol. Specialkarte Preuss. Thuring. Staaten, 1889, VIII, Heft 4, p. 6 (264), f.n. 1.

[2] De Koninck—Nouv. Rech. Anim. Foss. Terr. Carb. Belgique, Pt. 1, 1872, p. 65.

[3] On this point see Schlüter—Abhandl. Geol. Specialkarte Preuss. Thuring. Staaten, 1889, VIII, Heft 4, p. 8 (266).

[4] Thomson—Corals Carb. System Scotland, 1883, pp. 57–61.

[5] Whiteaves—Canadian Pal. Foss., 1884, III, Pt. 1, p. 3.

[6] Whiteaves—Canadian Pal. Foss., 1895, III, Pt. 2, p. 49.

This mode of increase is a very remarkable one, and excellent examples of it will be found in some of our illustrations of *Tryplasma* reproduction. The tabulæ of *Pycnostylus* appear to be always horizontal and complete. Were it not for the spined septal lamellæ of *Tryplasma*, the latter is, to all intents and purposes, a *Pycnostylus*.

It has already been stated, in the second section of this Memoir, that Dr. Clemens Schlüter made use of Dana's name *Calophyllum*, resuscitated by Dybowski, for a Devonian coral, which, from subsequent researches, appears to possess all the characters of *Tryplasma*. Now, *Calophyllum* has always been a stumbling-block in the path of students of Palæozoic corals. By Dana it was described[1] without type, or assigned species, as simple, caliculato-ramose or aggregate, with septa and concave tabulæ, but no dissepiments. The width of the septa was not stated, nor whether consisting of simple, vertical lamellæ, or the latter bearing spines or granules. Messrs. H. Milne-Edwards and Haime considered[2] that *Calophyllum* did not differ from *Amplexus*, and that Dana included in it very diverse forms.

Dybowski appears to have been the resuscitator of *Calophyllum*. On a previous page it was explained that he adopted the name for certain Silurian corals from the Baltic Provinces.[3] I think it may be accepted that of the two species described, the first (*Calophyllum Roemeri*) is a *Tryplasma*, although we are faced with the question of lateral budding in this instance. To obviate the difficulty caused by the halo of doubt overhanging *Calophyllum*, Dana, the late Prof. F. von Roemer proposed the name *Cœlophyllum*[4] to take its place, and as his type selected *Calophyllum paucitabulatum*, Schlüter. To the latter Author's definition, Roemer added the important statement that the radiating septal lamellæ are finely dentieulated, and even delicately notched. Now, this feature, if sustained, bearing in mind the otherwise simple structure of *C. paucitabulatum*, at once places *Cœlophyllum* on a level with *Tryplasma*. The structure described by Roemer was, indeed, corroborated by Dr. F. Frech[5], who, in redescribing the same coral, says without the slightest reservation, that the septal lamellæ are notched.

It appears, however, that *Cœlophyllum* was a preoccupied name, having been used by Quenstedt for a Mesozoic coral, I believe, and certainly in 1875 by Scudder as a genus of Orthoptera.

[1] Dana—Zooph. Wilkes U. S. Explor. Exped., 1846, p. 115.
[2] H. Milne-Edwards and Haime—Archiv. Mus. Hist. Nat., 1852, V, p. 347; Hist. Nat. Coral., 1860, III, p. 348.
[3] Dybowski—Mon. Zoantharia Scler. Rugosa, 1873, Pt. 1, p. 118.
[4] Roemer—Lethæa Pal., 1883, I, Lief. 2, p. 400.
[5] Frech—Dames and Keyser's Pal. Abhandlungen, 1886, III, Heft 3, p. 101.

To avoid this clashing, Schlüter in 1889 proposed *Cyathopedium*.[1] The characters of the genus are those of the type species *Calophyllum paucitabulatum*, as defined by Schlüter, who admitted the presence of dentieulations on the septal lamellæ in three specimens as described by Roemer, but considered this feature formed no real distinctive character of the genus. Experience gained through the study of the Australian *Tryplasmæ* leads me to believe that the observations of Roemer and Frech are to be relied on, and *Cyathopedium* will, therefore, become a synonym of *Tryplasma*. Schlüter's original longitudinal figure[2] of *Calophyllum paucitabulatum* certainly does not exhibit any septal spines; but this possibly arises from the fact that the section from which the figure in question was prepared did not bisect a septal lamella, or pass sufficiently near the wall to show the cut ends of the septal spines. Whiteaves suggested that *Orthopedium*, Schlüter, was probably a synonym of his genus *Pycnostylus*.[3] Does he refer to *Cyathopedium*, for I cannot find a reference to any genus of the former name described by Schlüter? I think it must be so, for Schlüter, on his part, places *Pycnostylus* as a synonym of his *Cyathopedium* with a note of interrogation. If the last-named stands, and the two are identical, then Whiteaves' name has precedence.

Mr. James Thomson[4] also made use of the name *Calophyllum*, Dana, but as *Calophyllum*, according to Roemer, has no generic stability, the value of Thomson's descriptions as a contribution to the general morphology of this supposed genus are completely discounted. At the same time, some very curious Carboniferous corals were so named by this Author. They are simple cylindro-conical corals with dissepiments and a fossula, into which one or more of the primary septal laminæ protrude, and at least two of the species are described with granular secondary septa. As *Tryplasma* regularly possesses both orders of its septa constantly spined, and neither true dissepiments nor a fossula, the Carboniferous corals in question need not be mistaken for the former.

We now come to the all important consideration of *Pholidophyllum*. I have endeavoured, in previous pages, to show, and hope to do so more conclusively in those that follow, the close and intimate relation existing between the structure of *Pholidophyllum* and my conception of that of

[1] Schlüter—Abhandl. Geol. Specialkarte Preuss. Thuring. Staaten, 1889, VIII, Heft 4, p. 5 (263).
[2] Schlüter—Verhandl. Nat. Vereines Preuss. Rheinl. Westfalen, 1881, VIII (4), t. 2, f. 4.
[3] Whiteaves—Canadian Pal. Foss., 1895, Pt. 2, p. 94.
[4] Thomson—Corals Carb. System Scotland, 1883, p. 63.

Tryplasma. Only one fundamental difference exists between *Pholidophyllum tubulatum* and the species I have referred to *Tryplasma*, both Australian and exotic. In no description of any of the latter have I noticed any reference to the exothecal structures described by Lindström adhering to the outer walls, or at the edge of the calice in *P. tubulatum*, and, similarly, there is no trace of these in any of the Australian forms. These scales were regarded by Lindström as homologous with the opercula of *Rhizophyllum* and its allies. If, therefore, the presence of such scales is essential to the stability of *Pholidophyllum*, and further, if *Tryplasma*, Lonsdale, is the equivalent of Lindström's genus, then I am fain to confess that our Australian corals cannot be so referred. The whole matter hinges on the question, are these exothecal scales homologous with the opercula of *Rhizophyllum*, *Calceola*, &c. ? In the well-considered words of a reviewer of Lindström's paper—"The Operculate Corals of the Palæozoic Formation"—"the walls were covered with vertical rows of regularly disposed, minute, overlapping calcareous scales or plates, oval or pear-shaped in outline, minutely striated on the outer surface, and with a small process on the inner surface as if in connection with a muscular attachment. The plates are in paired rows, each pair covering over the slight vertical furrow between two rugæ or costæ. Judging from their sections, one side of each scale seems to have been slightly embedded in the wall of the coral, but the attachment must have been slight, for examples in which these scales are preserved *in situ* are very rare." The reviewer added, "which in a certain sense are homologous with the opercula of the genera above mentioned." [1]

These lids, or "opercula" of the Palæozoic Operculate Corals, were also likened by Lindström to the opercular valves of the living genera *Primnoa* and *Paramuricea*.[2] He remarked:—"I think there exists some sort of homology to these ectodermic scales of the Primnoæ amongst the Rugosa in *Cyathophyllum* (*Pholidophyllum*, n.g.) *Loveni*, Edw. and H.,[3] specimens of this very common and widely distributed fossil show, when in a good state of preservation, a thick covering of small ($\frac{1}{2}$ mm.), very thin scales, tightly clustered together in longitudinal rows along the costæ. . . . . This position of the scales on the theca or epitheca of the coral gives them an exothecal character." [4]

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[1] G.J.H.—Geol. Mag., 1883, X (2), p. 133.

[2] Lindström—Geol. Mag., 1871, VIII, p. 122.

[3] Later placed as a synonym of *Pholidophyllum tubulatum*.

[4] Lindström—Geol. Mag., 1871, VIII, pp. 125-26.

It is not for me even to attempt to controvert the accuracy of Lindström's description of these scales; indeed, their presence is most satisfactorily shown in one of his enlarged figures.[1] May it not be possible that Lindström, led away by the importance of his wonderful discoveries of the operculate nature of the *Goniophyllum—Rhizophyllum* group of corals, attached too much classificatory importance to the presence of these exotheeal scales? It is significant that Dr. G. J. Hinde, in reviewing Lindström's great paper, said of the scales in question, as already quoted—"which, in a certain sense, are homologous with the opercula" of *Primnoa*, &c. It is equally striking that Lindström admits the absence of these scales on the outer corallite surfaces of the [sub] compound colonies. Why should they be absent? The colonies are not compound in the strict sense of the word, but sub-compound or sub-fasciculate, leaving quite sufficient space between individual corallites, here and there, for the attachment of scales.[2] If it be possible for a colony to develop its fistulæ between its component corallites, one would expect to find at least some trace of the scales also. Again, if it be the case that scales are not developed on exotic sub-compound colonies, it will explain their absence on our indigenous sub-fasciculate species. There remains the undoubted fact that, so far, no trace of exothecal scales has been observed on any of our simple forms, although very careful search has been made for them.

The structure of *Pholidophyllum tubulatum* and that of the corals here described as *Tryplasma* is so absolutely similar, it is impossible to conceive them to belong to other than one genus, notwithstanding the absence of these exotheeal scales in the latter. The same may also be said of those European Silurian and Devonian corals indicated in Part II of this Monograph, such as Dybowski's *Acanthodes*, *Cyathopedium paucitabulatum*, Schlüter, *Cœlophyllum eurycalyx*, Weissermel, and sundry species of so-called *Amplexus*.

The presence of exotheeal scales does not, to my mind, by any means necessitate the inclusion of *Pholidophyllum* in the "Anthozoa Operculata" of Lindström, any more than do the opercular scales of the recent genera *Primnoa* and *Paramuricea*. Indeed, Lindström did not so include *Pholidophyllum* in his own classification,[3] but contented himself by placing the description of the latter, with that of one other coral, at the end of his paper,

[1] Lindström—Bihang K. Sv. Vet-Akad. Handl., 1882, VII, No. 4, t. 5, f. 18.
[2] See Lindström's figure, *ibid.*, t. 2 f. 18.
[3] Lindström—Bihang K. Sv. Vet.-Akad. Handl., 1882, VII, No. 4, p. 10.

ruled off from the remainder, with the introductory remark quoted in the third paragraph, on p. 47. One of the principal characters of the "Anthozoa Operculata" is the highly vesicular nature of the corallum, a feature not met with in *Pholidophyllum tubulatum* any more than it is in the Australian *Tryplasmæ*, or any of the other corals here cited as probably congeneric. As a matter of fact, these are all distinguished, amongst other characters, by an entire absence of this tissue.

Again, the presence of spined septal lamellæ, or the spines represented by longitudinal rows of granules, cannot alone be accepted as distinctive of the "Anthozoa Operculata." Both these structures, wholly, or in part, are found in other corals, *e.g.*, [*Amplexus*] *Sowerbii* (Phill.), Thomson, [*A.*] *serpuloides* (De Kon.), Thomson, [*A.*] *irregularis*, Thomson, all from the Scotch Carboniferous[1]; in *Phryganophyllum Duncani*, De Kon.,[2] also Carboniferous; in *Cyathophyllum vermiculare* (Goldf.), Frech,[3] *Hallia quadripartita*, Frech,[4] and *H. callosa* (Ludwig), Frech,[5] all Devonian, whilst the pointed projections, or teeth, on the free edges of the septal lamellæ in such genera as *Heliophyllum*, *Crepidophyllum*, *Phillipsastræa*, &c., are so well known as hardly to need comment.

Reviewing the whole question dispassionately, and after giving full weight to the presence of the exothecal scales in *Pholidophyllum tubulatum*, it seems to me that more is to be gained by removing the latter, as a representative *Tryplasma*, from the vicinity of the Anthozoa Operculata, and, with other congeneric corals, placing it in a separate family, the Tryplasmidæ, with relations to *Amplexus* and *Pycnostylus*. With the two latter, *P. tubulatum* has already been shown to be closely allied in the absence of a fossula and dissepimental tissue, and the rudimentary nature of its septal apparatus.

The absence of the peripheral zone of endothecal tissue composed of dissepiments (with the possible exception of *T.* (?) *Murrayi*), so characteristic of the Order Cyathophylloidea, forbids the inclusion therein of the Tryplasmidæ. On the other hand, the Order Zaphrentoidea "comprises those corals in which there is a comparatively limited amount of dissepimental endotheca, the visceral chamber never being sheathed with a zone of vesicular tissue."[6]

[1] Thomson—Corals Carb. System Scotland, 1883, p.p. 58 and 59.
[2] De Koninck—Nouv. Rech. Anim. Foss. Terr. Carb. Belgique, Pt. I, 1872, p. 63.
[3] Frech—Dames and Kayser's Pal. Abhandl., 1886, III, Heft 3, t. 2, f. 3*a*.
[4] Frech—*Ibid.*, t. 8, f. 21.
[5] Frech—*Ibid.*, t. 8, f. 18.
[6] Nicholson—Man. Pal., 3rd Edit., 1889, I, p. 293.

Amplexus is usually associated with *Zaphrentis* in the Zaphrentoidea, but in the first instance I suggest that it be relegated to a family of its own —the Amplexidæ—with *Pycnostylus*, on account of their rudimentary septal lamellæ, the very poor development of dissepimental tissue, even when present, and by an inconstant fossula. This separation will then lead the way to the establishment of the Tryplasmidæ, characterised by the dentate or spinose free edges of the equally rudimentary peripheral lamellæ, or the reduction of the latter to mere rows of granules, and the entire absence of a fossula and also dissepiments, with the possible exception referred to above. The reproduction in the first family is sexual, or asexual by calicinal budding; in the second by parietal or calicinal budding, chiefly the latter, and mostly rejuvenescent.

In proposing the separation of *Amplexus* from the Zaphrentidæ I have, to some extent, been guided by the following remarks of Messrs. Thomson and Nicholson[1]:—"Upon the whole, therefore, these two genera [*Amplexus* and *Zaphrentis*] are marked off from one another by characters of a more fundamental and recognisable nature than those which separate *Zaphrentis* from *Cyathophyllum*."

The interseptal loculi, if they can be so called, in *Tryplasma* are usually filled with stereoplasma, as in the Hadrophyllidæ, but in that family there is a septal fossula, and the septal lamellæ are entire, but dissepiments are not present. A fossula is also present in the Palæocyclidæ, but as to the existence of tabulæ authorities differ, and as in the Tryplasmidæ, the septal lamellæ are rudimentary, and with crenulated free edges. Zittel and Nicholson refer to the absence of tabulæ and dissepiments in the Palæocyclidæ, but Duncan describes both.[2] To separate *Amplexus* from the Zaphrentidæ, and to place *Tryplasma* in a family of its own, seem to tend towards the simplification of a rather complex subject.

Lindström, in 1882,[3] made use of the name *Polyorophe* for an Upper Silurian coral. This was described as a composite coral with obovate or elliptic corallites "emitting frequent, large, broad hooks laterally, which connect adjoining polyparies"; the septa being represented by numerous lines of low, blunt spines. The tabulæ are complete, spaced, and nearly horizontal, and the epitheca quite smooth. The only other author

[1] Thomson and Nicholson—Ann. Mag. Nat. Hist., 1875, XVI (4), p. 424.
[2] Duncan—Phil. Trans., CLVII, p. 651.
[3] Lindström—Bihang K. Sv. Vet.-Akad. Handl., 1883, VIII, No. 9, p. 12.

who has referred to this coral, so far as I can ascertain, is Weissermel,[1] who does not throw any further light on its structure or relations. It is evidently related to *Tryplasma*, but from want of knowledge I am not able to pursue the matter further.

One last point remains to be referred to. It is highly probable, as Lindström points out,[2] that some at least of the small simple corals placed in *Turbinolopsis* and *Petraia* are referable to *Tryplasma* (*Pholidophyllum*). He mentions one species, *Turbinolopsis* (*Petraia*) *bina*, Londsdale, Phillips, McCoy, &c.

[1] Weissermel—Zeitsch. Deuts. Geol. Gesellsch., 1894, XLVI, Heft 3, p. 637.

[2] Lindström—Bihang K. Sv. Vet.-Akad. Handl., 1882, VII, No. 4, pp. 65–66.

IV.—GENERAL STRUCTURE[1] OF AUSTRALIAN TRYPLASMÆ.[2]

1. *Corallum or Colonies.*—The species of our *Tryplasmæ* present four types of growth. In three, *T. Lonsdalei*, and its varieties, *T. congregationis* and *T. delicatula*, the corallum is always in the form of fasciculate or subfasciculate masses of considerable size, the degree of contiguity of the corallites to one another varying considerably. In *T. Lonsdalei*, and its var. *scalariformis* the growth is loose and open, whilst in the var. *minor* it is compact. In well-grown colonies, particularly of the var. *scalariformis*, the corallites certainly radiate from one original point of growth. In *T. congregationis* the colony is composed of closely arranged corallites, or separated from one another by moderate interspaces.

The second group consists of *T. columnaris* and *T. dendroidea*. These possess a close external resemblance to some species of *Amplexus, e.g.*, *A. coralloides*, J. Sby., in their long, columnar outline. The resemblance is intensified on transverse fracture by the appearance of the wide tabulate area of each corallite.

The third section comprises *T. princeps*, *T. liliiformis*, and *T. derrengullenensis*. The corallites of *T. princeps*, our largest solitary species, were, in their first stage, simple, ultimately forming gemmiferous bundles of considerable size. It is probable that *T. liliiformis* must be associated with *T. princeps* in its form of growth., for I have not seen any indication that the corallites commenced their existence other than as solitary individuals ultimately becoming bunches or aggregations by repeated budding, but of a looser formation than in *T. princeps*.

The fourth and last section consists of one species, *T. wellingtonensis* in which the corallite, at first simple and solitary, by repeated single calicinal gemmation, gave rise to a chain of individuals, more or less retaining the habit of the parent corallite.

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[1] Throughout Parts IV and V the following special terms need definition :—

Radiciform processes.—Exothecal processes used as anchoring rootlets.

Fistulæ.—Exothecal hollow tubes uniting contiguous corallites.

Bourrelets.—Circumferential swellings on the corallites, representing growth periods or the edges of old calices.

Costæ.—Longitudinal exothecal ribs, or ridges, corresponding to primary septal lamellæ.

Rugæ.—Longitudinal exothecal ribs, or ridges, corresponding to secondary septal lamellæ.

Septal lamellæ.—Initial continuous laminæ of the septal apparatus, extending from top to bottom of the corallites.

Septal spines.—Denticles or spines forming the free inner or distal edges of the septal lamellæ.

[2] Omitting from consideration that of *T.* (?) *Murrayi*.

The mode of growth merely,[1] in one section of this genus, typified by *T. Lonsdalei*, recalls that of several well-known genera of Cyathophyllidæ, such as the fasciculate species of *Lithostrotion*, *Diphyphyllum*, *Cylindrophyllum*, &c. The nature of the septal apparatus, however, absence of dissepimental tissue and septal loculi, or any form of peripheral tissue whatever, and the want of a fossula, will, on more attentive examination, at once distinguish the members of this section from these and their allies.

2. *Corallites.*—In the sub-fasciculate species, and in *T. vermiformis*, the corallites are always long, generally slender, and cylindrical, straight or slightly flexuous, and gradually increasing in size upwards, round or oval. The greatest length yet measured of one of these corallites is six inches, the diameter varying from five to fifteen millimetres. The corallites of *T. Lonsdalei* var. *minor* are uniformly of the least diameter, five millimetres, those of *T. Lonsdalei* proper, the next in progression, from six to eight millimetres; those of the var. *scalariformis* six to ten, and even reaching to fifteen millimetres at points in their courses immediately preceding gemmiferous bifurcation, and imparting to such corallites a stronger and much more robust appearance; the largest are those of *T. congregationis*, in which the normal diameter varies between ten and fifteen millimetres. The corallites are free during some portion of their course, and here and there united laterally by their walls, or by cylindrical fistulæ. In *T. congregationis* a larger proportion of the corallites appear to be united laterally than in the other species, and the fistulæ are here developed to their greatest extent; the corallites of this species are also noticeable from a less regular longitudinal outline, frequently enlarging and contracting in diameter.

Long cylindrical corallites are again met with in *T. columnaris* and *T. dendroidea*, and in both are either straight, with a characteristically pipe-like appearance, or slightly flexuous for short distances. With the ultimate form of growth of *T. columnaris* we are not acquainted, but in *T. dendroidea* budding probably brought about an open shrub-like corallum; the former attains the largest diameter of any of the cylindrical species, from fifteen to twenty-five millimetres.

In the following species the early stage was simple, cylindro-ob-conical, or turbinate, retaining this form until the first gemmation took place. The cylindro-ob-conical type is seen in its fullest extent in *T. princeps*, which is also the largest species of this section of the genus. The large, stout corallites

[1] Omitting the fistulæ from consideration.

are either straight, or slightly curved, retaining the same diameter for some distance, or expanding slowly upwards; in this condition of the corallum the resemblance to such corals as *Cyathophyllum giganteum*, Mich., is very marked; by copious budding large bunches of corallites are formed. The turbinate outline is seen in the earlier stages of each corallite in *T. wellingtonensis*, then passing into a more irregularly cylindrical condition, often twisted, or even slightly contorted. In *T. princeps* the base is pointed, but in the previous form it may be in the same condition, or somewhat expanded; in both the section is circular or oval, the diameter of *T. princeps* attaining two and a half inches, but that of its fellow is far less. The corallites of the former vary in length, but are known to extend to eleven inches, those of *T. wellingtonensis* being comparatively short at first, but by repeated gemmation forming a line of individuals four inches, and probably more, in length. Ob-conical to cylindrical corallites also characterise *T. derrengullenensis*, and may become twisted or contorted; this species bears the distinction of presenting the greatest outward resemblance to *T.* (*Pholidophyllum*) *tubulatum*.

In *T. liliiformis* the corallites are liliaceous in outline—*i.e.*, there is a stalk or stem-like portion below, resembling a non-budded corallite of *T. dendroidea*, varying much in length, and expanding above into wide bell-mouthed calices, as much as three inches in diameter. As a rule these corallites are erect, but are sometimes diverted to one side or the other, although not contorted.

3. *Wall.*—In all these corals the wall proper must have been thin and delicate. More often than not fossilisation has removed it, but when present the wall is always represented by a thin, dark circle supported inwardly by a zone of secondary deposit of variable thickness. In some instances the bases of the septal lamellæ are distinctly traceable to this thin theca, and it may, in consequence, be justly concluded that this latter is formed by the confluent bases of the septal lamellæ.

4. *Epitheca.*—I am but imperfectly acquainted with the nature of this investment; it is seldom preserved, and if so, only indifferently. So far as one can see, it consisted of a thin layer of tissue concentrically lined, the strength and distance apart of the threads varying according to species. This epithecal layer also clothed the radiciform processes and fistulæ.

5. *Exothecal Scales.*—No trace whatever of these much debated scales, first noticed by Lindström, and compared by him to the opercula of *Primnoa*,

and by analogy to those of the Palæozoic Operculata, has been detected. So many specimens have now been examined, upwards of three hundred, that had these structures existed some trace must have come under notice.

6. *Bourrelets or Accretion Swellings.*—Throughout the Australian *Tryplasmæ* the bourrelets do not form an important feature. In *T. Lonsdalei* these swellings were very slight; in *T. vermiformis* represented by delicate, equal, rounded rings, closely following one another. In *T. congregationis* and *T. columnaris* they are irregularly developed, and are stronger and more projecting than in any of the other species, with the exception of one doubtful example (Pl. XVII, fig. 6) of *T. princeps*. In some instances, at any rate, these represent the margins or edges of old calices. I believe this to be the case in *T. wellingtonensis*.

7. *Radiciform Processes.*—These are tubular prolongations of a corallite wall, and were used as anchoring filaments, single or in clusters. In some the tubular or hollow nature is very apparent (Pl. XXII, fig. 10), accompanied by a stereoplasmic thickening arranged in concentric layers. They have not been observed in all species, particularly the sub-fasciculate forms, but in *T. princeps* are very noticeable, especially towards the bases of the corallites, although they do occur at all heights. Radiciform processes are also met with in *T. wellingtonensis*, but sparingly so, both towards the bases of the corallites and around the exterior of the calice margins. They occupy the same positions in *T. liliiformis*, but in contradistinction to *T. wellingtonensis*, were well developed, and of considerable length.

These anchoring stolons are quite as well developed in *T. princeps* and *T. liliiformis* as they are in the genus *Omphyma* (*e.g.*, *O. subturbinata*, D'Orb.). If Nicholson's statement that the rootlets in this genus are simply exothecal structures is correct,[1] then a marked difference exists between the latter and the radiciform processes of *Tryplasma*, which are, as already explained, prolongations of the general visceral cavity of the coral. Specimens of *O. subturbinata* in the Australian Museum collection certainly appear to me to possess hollow processes.

Lindström records the interesting fact that radiciform processes "distinguish no less than eleven genera of the *Cyathophyllidæ*."[2] He explained their formation as follows:—"The membrane which lined and secreted the walls of the calyx then formed small branches, which also

[1] Nicholson—Man. Pal., 3rd Edit., 1889, I, p. 288.
[2] Lindström—Geol. Mag., 1866, III, p. 358, f.n. 1.

secreted calcareous matter around themselves, and thus formed these root-like tubes."[1] In all probability these radiciform processes are hollow and tubular throughout the whole of the Cyathophylloidea, and not exotheeal. Lindström has also demonstrated the presence of such anchoring filaments connected with the interior of the calices in some of the Operculata, such as *Rhizophyllum gotlandicum*, *R. elongatum*, and possibly in *Goniophyllum*; in *R. elongatum* these tubes are tabulate,[2] and in *R. attenuatum* become actually stoloniferous, giving rise to new corallites.[3]

In some cylindrical or conical corals these radiciform processes are developed on all sides of the corallite, but in others only on one; in the latter case this probably represents the underside, or that to which the corallite is inclined.

8. *Fistulæ.*—These are present in two of the three sub-fasciculate species and one of the ob-conical forms, forming a prominent feature in *T. Lonsdalei*, even more so than in its two varieties, and are present in all parts of the corallum, but placed at irregular distances from one another. It is in *T. congregationis* that these connecting processes are seen in their fullest development at regular stated intervals between corallites, tier above tier. The young corallites, or buds, in *T. princeps* are united by fistulæ—a very interesting point in the morphology of these corals.

The processes are more or less horizontal, usually swollen at their points of projection from the corallites, diminishing in diameter in their median course. They are tubular, and, like the radiciform processes, are not only prolongations of the visceral cavities of the corallites they unite, but are partially filled with concentric stereoplasma. In *T. Lonsdalei* the septal spines continue quite into the mouths of the fistulæ, and in one instance a spine was observed in the open tube course (Pl. XXVI, fig. 7).

The presence of fistulæ in *Tryplasma* recalls the structure of the *Eridophyllum* group on the one hand, and the systematically distant *Syringopora* on the other. There is, however, this difference between the fistulæ of *Tryplasma* and the processes connecting the corallites in *Eridophyllum*—that, whilst the fistulæ in the former are projected indiscriminately from all sides of a corallite, there does seem to be a marked protrusion of processes from one side only of each corallite in a given corallum

[1] Lindström—Geol. Mag., 1866, III, p. 406.
[2] Lindström—Bihang K. Sv. Vet.-Akad. Handl., 1882, VII, No. 4, t. 2, f. 15 and 16.
[3] Lindström—Bihang K. Sv. Vet.-Akad. Handl., 1882, VII, No. 4, t. 3, f. 17.

in the latter.[1] On the other hand, the arrangement in *Syringopora* agrees with that of *Tryplasma*, and, like the latter, the fistulæ of the former are hollow and extensions of the visceral cavities; but the processes in *Eridophyllum* proper "are not connected with the interior of the coral."[2] In one species of *Eridophyllum* (*E. simcoense*, Bill.), Rominger has already noticed the resemblance to *Syringopora*. In describing the last-named coral as a *Diphyphyllum*,[3] he says:—"The stems laterally connect by slender, transverse processes, similar to the transverse tubules of *Syringopora*—not, however, making communication between the visceral cavities, as in those, but merely fastening externally to the walls for mutual support."

This coral has been placed by Mr. G. B. Simpson in a new genus, *Synaptophyllum*, the connecting processes proceeding from all sides of a corallite, the expansions of adjacent corallites opposite, hollow, and meeting and coalescing midway between, but intercommunication cut off by a partition formed of the wall of one of the processes. Connecting processes also occur in *Schœnophyllum*, Simpson, and *Placophyllum*, Simpson.[4]

9. *Rugæ*, or *Pseudocostæ*.—Costæ are not present in the Australian *Tryplasmæ*, but the vertical, more or less parallel ridges traversing the exterior of the corallites from top to bottom, correspond to the secondary septal lamellæ, and not to the primary; in consequence of this, they are probably more nearly allied to rugæ or pseudocostæ. They appear to be the exothecal edges of the secondary septal lamellæ, as the costæ are those of the primary in other corals, and do not call for any special remark, except that neither granules nor teeth, or other special ornamentation, have been seen on them.

10. *Calices*.—In the few instances in which the calice is known, it has always proved to be deep, and in its lower course straight-walled. The calices of *T. princeps*, *T. wellingtonensis*, *T. derrengullenensis*, and *T. liliiformis* fulfil these conditions; but in the last-named the upper portion expands into a wide bell-mouth cavity, with a flange-like periphery. The floor may be either concave, oblique, or rolling, sometimes horizontal, and is formed by the uppermost tabula, on to which the septal spines project more or less, according to species.

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[1] Milne-Edwards and Haime—Archiv. Mus. Hist. Nat., V, t. 8, f. 6, t. 10, f. 4*b*; Nicholson—Pal. Ontario, Pt. 1, 1874, p. 34; Simpson—Bull. N. York State Mus., 1900, VIII, No. 39, p. 214.

[2] Simpson—Bull. N. York State Mus., 1900, VIII, No. 39, p. 213, f. 37, p. 214.

[3] Rominger—Geol. Survey Michigan, Lower Peninsula, 1873–76, III, Pt. 2, 1876, p. 123.

[4] Simpson—Bull. N. York State Mus., 1900, VIII, No. 39, pp. 214–16.

11. *Septal Lamellæ and Spines.*—We may now consider the most important feature of this group of corals—the structure of the septal apparatus. This consists primarily of narrow longitudinal lamellæ, extending from top to bottom of every corallite, and which spring from the theca as in other sclerodermic corals; and secondly, the distal or inward edges of these lamellæ are broken up into spines of greater or less length, but never attaining any great degree of length; the septal apparatus may, therefore, be described generally as marginal or peripheral. This feature is common to and constant throughout the whole group, varying only in degree specifically. There is a decided, although at times slight, difference in length of these spines in alternate rows, indicating the presence of primary and secondary lamellæ, the secondary spines being occasionally reduced to mere granules on the free edges of the lamellæ. The spines, thorn-like projections, invariably point upwards obliquely in the direction of growth of the coral, and form a good index for determining the upper and lower surfaces of a colony when this is not otherwise apparent; horizontal spines are here and there present also, as well as laterally curved, but these cannot be regarded as other than occasional. The number of cycles in an intertabular space does not appear to follow any constant rule, these cycles varying from one to four, and in some cases more. In *T.* (*Acanthodes*) *tubulum*, Dyb., and *T.* (*Acanthodes*) *rhizophorus*, Dyb., four cycles occur, but in *T.* (*Acanthodes*) *cylindrica*, Dyb., there appears to be only one.

The septal spines are neither tubular nor hollow, although so described by Lonsdale and Dybowski. Von Koch says that the central line [primordial septum] in each is dark coloured in *T.* (*Pholidophyllum*) *Loveni*, Ed. and H.,[1] and this is frequently to be seen in sections of our species.

In transverse sections prepared for the microscope, the septal spines often appear much broken up, and dot like—this is due to the section cutting the upwardly projecting spines of more than one cycle. Similarly, when a longitudinal section is cut eccentrically and close to some portion of the corallite wall, the same cut ends again appear as so many vertical lines of disconnected dots.

The lamellæ in *T. Lonsdalei* and *T. princeps* are very narrow, and purely marginal in *T. wellingtonensis* and *T. liliiformis*; they are stout and strong in *T. princeps*, but very delicate in *T. congregationis*. The separation into primary and secondary is distinctly marked in *T. Lonsdalei* and *T.*

[1] Weissermel—Zeitsch. Deuts. Geol. Gesellsch., 1894, XLVI, Heft 3, p. 640.

vermiformis, but most so in *T. wellingtonensis*. On the other hand, there is hardly any distinction between the two orders in *T. congregationis*, whilst in *T. princeps* and *T. columnaris* the amount of disparity is variable. The two extremes in number to a cycle lie between *T. vermiformis* with twenty-eight, and *T. delicatula* with thirty-three, to *T. columnaris*, *T. liliiformis*, and *T. princeps* with eighty. As regards typical development, *T. Lonsdalei* presents the best example.

The primary spines are longest in the species first mentioned and in *T. wellingtonensis*, in which they extend into the visceral chambers for at least one-third of the diameter of the latter; they are long and tapering in *T. columnaris*, very short in *T. congregationis* and *T. liliiformis*, and delicate in the last species but one. The secondary spines are very short in *T. vermiformis*, and reduced to mere granules in *T. wellingtonensis*.

The direction is, as a rule, obliquely upward, although in the last-named species and *T. liliiformis* horizontal spines have been detected, and in *T. princeps* there are some laterally curved. In *T. Lonsdalei* some of the spines are laterally denticulated, and in *T. derrengullenensis* there appear to be more cycles of secondary lamellæ than primary in a given space, at any rate in the calice.

Septal lamellæ spined on the distal or free edges are by no means unknown in genera of Cyathophylloidea—for instance, in the Heliophyllidæ they occur as transverse ridges or teeth, *e.g.*, *H. arachne*, Hall.[1] Passing to the Zaphrentoidea we meet with the curious little *Palæocyclus* (if this genus is correctly referred to this order), in which the free edges of the lamellæ are strongly echinulate. Moreover, in *Heliophyllum* and in some species of *Phillipsastræa* the lamellæ are provided with lateral carinæ, *i.e.*, oblique lamellar ridges directed inwards and upwards, which Nicholson compared[2] to the septal spines of *Tryplasma* (*Pholidophyllum*), and by analogy they may be equally compared to the lateral denticles on the spines in *T. Lonsdalei*. In all the corals mentioned there is this manifest difference—that whilst in them the lamellæ extend to the centre of each corallite, and are therefore true septa, in the *Tryplasmæ* they are simply peripheral.

In contemplating the septal apparatus of *Tryplasma*, it is impossible to divest one's mind of the strong resemblance of the spines to those of some

[1] Hall—Ill. Dev. Fossils: Corals Up. Helderberg and Hamilton Groups, 1876, t. 24, f. 10.
[2] Nicholson—Man. Pal., 3rd Edit., 1889, I, p. 289.

Farosites. By this I do not mean to infer any systematic relation between the two groups, but simply a connection in the light of comparative morphology.

A few words on the septal lamellæ and spines of the Operculate Corals (Caleeolidæ) will not be out of place. In these corals the septal apparatus is incomplete and rudimentary, or even obsolete; in *Goniophyllum* and *Calceola*, although marginal, it is truly lamellar; in *Rhizophyllum* there are septal striæ; in *Aræopoma*, these are again reduced to lines of tubercles. On the whole, therefore, the septal characters of *Tryplasma* do not entirely agree with those of the Operculate Corals any more than they do with any other group of the Rugosa.

In the historical portion of this Memoir, I referred at some length to the supposed existence of canals traversing the wall, as described by Lonsdale, and showed these to be nothing more than cavities left by the removed septal spines. In by far the greater number of instances our *Tryplasmæ* are met with in the decorticated state—devoid of the theca—which has been worn off either during or subsequent to fossilisation. If this form of disintegration is carried sufficiently far to remove the septal lamellæ also, one or the other of the following conditions is apparent:—*a*, The remaining portion of the corallite is traversed by longitudinal rows of circular dots, which are the fractured bases of the septal spines; *b*, or by holes instead of dots, leading to short tubuli, which are simply moulds left by the dissolved spines. Many beautiful examples of these are in our collections, and in the case of the tubuli none better need be referred to than the small example of *T. derrengullenensis* (Pl. XXII, figs. 6 and 7), in the calice east of which are several cycles of "canals." In species possessing differentiatedprimary and secondary lamellæ, the lines of pits will always be found to be larger and smaller alternately.

12. *Loculi*.—In consequence of the narrowness of the lamellæ septal loculi do not exist (even in *T.* (?) *Murrayi*), the short interspaces between the bases of the lamellæ being invariably filled with a secondary deposit, leaving the spines only free.

13. *Dissepiments*.—The remarks made in the last paragraph naturally prepare one for the absence of any endothecal tissue of the nature of dissepiments. So far no satisfactory evidence of their presence exists, with the sole exception of *T.* (?) *Murrayi*, which will be referred to later on; at any rate, certainly not in the subfasciculate species. On first describing *T.*

wellingtonensis[1], I wrote as follows when speaking of an intra-marginal ring in some of the corallites :—" It is, in all probability, not formed by a series of dissepiments in a single line, but is the primitive theca in the substance of the outer investment, and septa traversing this zone have an intra and extra thecal portion. In a rather more complete section (Pl. XXI, Figs. 11 and 12) an inner ring is visible which might be taken for a further series of dissepiments; it is, however, a second corallite springing from within the outer one." I have not seen any reasons to alter this view.

The almost total absence of dissepimental tissue at once recalls to mind the genera *Amplexus* and *Pycnostylus*, and a number of other Rugose genera with complete septal lamellæ[2].

14. *Tabulæ.*—One of the most conspicuous features of the corallum in all the species. The distance apart of these floors is of too variable a nature to be a reliable factor in specific description, except in one or two instances. In a comparative sense the tabulæ may be either distant or much crowded together, and in one species (*T. Lonsdalei*) this crowding occurs in clusters so constantly as to become of specific importance. The tabulæ are both complete and incomplete in all but one species, the complete often largely predominating over the incomplete. The complete tabulæ extend entirely across the corallites, from wall to wall, and may be either horizontal, concave, oblique, convex, or rolling, and more than one of these characters may be common to a species.

In the descriptions of two of the already known species (*T. wellingtonensis* and *T. Lonsdalei*), I questioned the actual union of the complete tabulæ with the corallite walls, but I am now convinced that a union is the case invariably. Dybowski described the tabulæ as ceasing at the inner or distal ends of the septal spines without reaching the proper wall; but he was probably misled, like myself, by deceptive appearances. He accounted for this, however, on the supposition that the spines are too closely packed to permit of the floors joining the wall, but it is now quite evident to me that the latter had a connection with the wall of their corallite as a support.

The incomplete tabulæ invariably give rise to a vesicular tissue, but this must not be confounded with the general vesicular structure of the Cystiphylloidea, particularly that of the operculate division; and herein lies one of the fundamental differences between this group and the

[1] Etheridge—Rec. Geol. Survey N. S. Wales, 1895, IV, Pt. 4, p. 162.
[2] *See* Sherzer—American Geol., 1891, VII, No. 5, pp. 281, 287.

Operculata. In the present instance, it arises from the inosculation of the tabulæ with one another, giving rise to triangular and wedge-shaped or lenticular vesicles, but not blister-like or sub-globular as in *Cystiphyllum* and its allies. The wedge-shaped vesicles are usually marginal, short, and sometimes deep, the lenticular more often occupying the centre of a corallite. In every corallite in which these vesicular tabulæ are a feature, there is always a certain number of complete floors, and no case of a corallite's visceral chamber filled with the vesicular type alone has come under notice. In the Operculata in particular, the interior structure of the corallites is wholly composed of true endothecal vesicles. Such is the case in *Goniophyllum*, *Rhizophyllum*, and *Araeopoma*, whilst *Calceola* so far differs that the internal structure is dense, but at the same time very finely vesicular. In one species of *Tryplasma* (*T. vermiformis*), vesicular tabulæ have not been observed.

In fractured or weathered horizontal sections, the peripheries of the complete tabulæ often present a series of short depressions or nicks, which are the imprints of the septal spines resting on them. In three species—*T. columnaris*, *T. derrengullenensis*, and *T. delicatula*—a very interesting feature was discovered in the presence of upstanding spines scattered over the upper surfaces of the floors; these are placed irregularly, or arranged in groups. In transverse sections prepared for the microscope, these appear as dark spots, or as dark rings with a refractive centre, and in either case often surrounded by a concentric secondary thickening. A similar structure was observed by Lindström in his *Pholidophyllum lubulatum*.

Oblique complete tabulæ appear to be absent in *T. vermiformis*, and possibly in *T. liliiformis* also, but are present in the other species; rolling tabulæ are met with in *T. Lonsdalei*, *T. congregationis*, *T. columnaris*, *T. princeps*, *T. wellingtonensis*, and occasionally in *T. liliiformis*; typical concave floors are to be seen in *T. Lonsdalei* and *T. liliiformis*, and those with an upward convexity in *T. congregationis*. Marginal vesicular tabulæ are present in *T. Lonsdalei*, elongately lenticular in *T. congregationis*, both conditions in *T. columnaris* and *T. princeps*, and irregular lenticular vesicles in *T. wellingtonensis* and *T. liliiformis*.

The wide tabulate non-septate area of *Tryplasma* again calls to mind the structure of the non-dissepimental genera *Amplexus* and *Pycnostylus*.

15. *Fossula.*—I cannot detect any trace of a septal fossula in *Tryplasma*; my observation is, therefore, in accord with Dr. Lindström's description of *Pholidophyllum*. In the complete horizontal, oblique, or rolling tabulæ of

T. Lonsdalei and *T. delicatula* a small central or eccentric depression or pit is often to be seen, but it has no connection with the septal lamellæ, and cannot be regarded as representing a fossula.

On the other hand, Mr. Rudolph Ludwig figured as *Zaphrentis caudata*,[1] a coral from the German Devonian, with the most unmistakable septal characters of *Tryplasma*, and, in addition, a large fossula. For this and cognate species, Mr. A. F. Foerste has suggested the name of *Palæocyathus*,[2] and includes in it an Australian coral, *Cyathophyllum australe*, Foerste,[3] common in the Bowning beds, and which certainly is not a *Tryplasma*. It may possibly be, therefore, that *Palæocyathus* will prove a convenient resting place for *Tryplasma*-like forms with a fossula.

16. *Gemmation.*—Lonsdale described the budding of *Tryplasma* as parietal, "chiefly from the sides of the parent stem"; Dybowski said the gemmation of his *Acanthodes* was parietal also, and gave a figure[4] of *A. tubulus* in which it appears to be so, but at the same time mentioning its rarity. On the other hand, Lindström refers to that of *Pholidophyllum* as calicular. In my first description of *T. Lonsdalei* I favoured the view of Lonsdale and Dybowski, and believed I had detected a few instances of parietal budding in specimens from Hatton's Corner, near Yass.[5] In the blocks of sub-fasciculate corallites from this locality it is very difficult to say exactly of what nature the budding is, but in a more recently collected specimen from a continuation of the same bed at Humewood, near Yass, it is so unquestionably calicular that I feel compelled to abandon my preconceived idea of the method in this species, more particularly as the var. *scalariformis* exhibits similar budding (Pl. XXVI, figs. 8–10).

In *T. Lonsdalei*, therefore, two buds arise from the parent calice (Pl. X, fig. 3), and immediately diverge from one another, but in the variety previously mentioned the young corallites are united laterally for some distance before diverging (Pl. XII, fig. 2). In *T. congregationis* two buds are present on one specimen (Pl. XIII, fig. 1), united only for a short distance, and then bending outwards. In *T. liliiformis* two to three young corallites arise from within the mature expanded cup. The gemmation is single in *T. wellingtonensis*, so far as known, the new corallite either continuing its upward course from an attenuated base, or at once filling the parent calice.

[1] Ludwig—Palaeontographica, 1865, XIV, Lief. 4, p. 170, t. 42, f. 2, 2*a*, f.
[2] Foreste—Bull. Sci. Lab. Denison Univ., 1888, III, f. 12*a*.
[3] Foreste—*Loc. cit.*, p. 128, t. 13, f. 12–14.
[4] Dybowski—Mon. Zoantharia Scler. Rugosa, Pt. 1, 1873, t. 1, f. 13, *section*.
[5] Etheridge—Rec. Geol. Survey N. S. Wales, 1890, X, Pt. 1, p. 19.

It is, however, in *T. princeps* that gemmation is seen in its most vigorous aspect. A series of buds, in one case as many as thirteen (Pl. XIX, fig. 2) arise around the inner edge of the calice of the completed single corallum, and in their turn become well-developed corals, forming a proliferous sub-compound cluster. A similar form of increase is met with in *T.* (*Cœlophyllum*) *eurycalyx*, Weissm.[1] Even in so small a form as *T. derrengullenensis* four buds are attached to one calice; budding seems to have commenced at a very early stage in this species.

In *T. vermiformis* there are two or four buds, which curve outwardly from the parent. In the case of four, reproduction is exactly similar to that of Whiteaves' *Pycnostylus guelphensis*,[2] four equal buds usually occupying the whole of the interior of the parent calice, and each deltoid-triangular in sectional outline; this resemblance is very remarkable. Increase in *T. dendroidea* is by two to four large vigorous buds, which soon diverge from the parent stem (Pl. XIV, fig. 1; Pl. XV, fig. 5).

In a remarkably interesting paper "On the Mode of Growth and Increase amongst the Corals of the Palæozoic Period,"[3] the late Prof. H. A. Nicholson subdivided gemmation, or increase, under five heads, viz.:—

1. Simple calicular gemmation.
2. Compound calicular gemmation.
3. Parietal or lateral gemmation.
4. Basal gemmation.
5. Fission.

Gemmation in the Australian *Tryplasmæ* is confined to Sections 1 and 2, and possibly 3, and the species group themselves as follows:—

Section 1.—*T. wellingtonensis* and possibly *T.* (?) *Murrayi*.

Section 2.—The remainder, with the exception of *T. delicatula* and *T. columnaris*, in which the budding is unknown.

Dr. Lindström drew attention to a very interesting point in the growth of new calices within the old ones in the Zoantharia Rugosa,[4] and which is not, strictly speaking, true calicinal budding. He instanced a specimen of *Goniophyllum pyramidale*, His., in which a new coral was formed within the calice of an older individual, and partly so of the old walls of the latter.

[1] Weissermel—Zeitssch. Deuts. Geol. Gesellsch., 1894, XLVI, Heft 3, p. 636, f. 1 and 2.

[2] Whiteaves—Canadian Pal. Foss., 1884, II, Pt. 1, t. 1, f. 1*b*; Lambe—Contrib. Canadian Pal., 1901, IV, Pt. 2, t. 10, f. 4, 4*a*.

[3] Nicholson—Trans. R. Soc. Edinb., XXIV, pp. 237–243.

[4] Lindström—Geol. Mag., 1866, III, p. 360.

"It is very evident," he says, "that no new individual is here formed by means of budding, as the calyx and the walls are quite the same as before, with the exception of that corner" representing the new corallite. "This peculiar formation of a new calyx within the old is common to almost all individuals of *Z. rugosa*, and is repeated several times by the same individual"; Lindström cites as an example the genus *Chonophyllum*. To this method of continuity of the species Nicholson applied the term "rejuvenescence," and said:—"On this view the original polype undergoes periodic contraction and partial death, only the central part of the animal retaining its vitality. Each period of contraction is, however, followed by one of active growth."[1] No finer example of this can be adduced than Schlüter's figure of the budding of *Cyathopedium paucitabulatum*.[2] On the other hand, in true calicular budding the original polype throws up from its calicinal disc one or more new corallites, which kill the parent completely; of this condition a good example may be found in the Carboniferous *Lonsdaleia rugosa*.

This rejuvenescent calicular gemmation has been excellently figured by Von Koch, as already explained, in *T.* (*Pholidophyllum*) *tubulatum*; by Weissermel in *T.* (*Cœlophyllum*) *curycalyx*[3]; and by Lindström in *Rhizophyllum elongatum*.[4] How extensively it is developed in our Australian *Tryplasmæ* the accompanying plates will show.

In the light of *Tryplasma tubulus*, Dybowski, it is quite possible that parietal budding occurs in the genus as the exception and not the rule; the former's sectional figure of this species certainly does appear to show two lateral buds.

17. *Geological Range.*—The whole of the Australian *Tryplasmæ* are of Upper Silurian age, no satisfactory evidence having yet come to hand of the occurrence of the genus in our Devonian rocks.

18. *Species.*—The following are the Australian species:—

Tryplasma columnaris, sp. nov.		*Tryplasma Lonsdalei*, Eth. fil.	
,,	*congregationis*, sp. nov.	,,	*princeps*, sp. nov.
,,	*delicatula* ,,	,,	*vermiformis* ,,
,,	*dendroidea* ,,	,,	*wellingtonensis*, Eth. fil.,
,,	*derrengullenensis* ,,	,,	(?) *Murrayi* ,,
,,	*liliiformis* ,,		

with two varieties of *T. Lonsdalei*, and two doubtful forms.

[1] Nicholson—Man. Pal., 3rd Edit., 1889, I, p. 254.
[2] Schlüter—Verhandl. Nat. Hist. Vereines Preuss. Rheinl.-Westf., 1881, VIII (4), t. 2, f. 1–3.
[3] Weissermel—Zeitsch. Deuts. Geol. Gesellsch., 1894, XLVI, Heft 3, p. 636, f. 1 and 2.
[4] Lindström—Bihang. K. Sv. Vet.-Akad. Handl., 1882, VII, No. 4, t. 2, f. 18.

V.—DESCRIPTION OF GENUS AND SPECIES.

Genus—TRYPLASMA, *Lonsdale*, 1845.

Tryplasma, Lonsdale, Murchison's Geol. Russia in Europe, 1845, I, p. 613.

Pholidophyllum, Lindström, Öfvers Vet. Akad. Forhandl., 1870, p. 925, *f.n.*

„ Lindström, Geol. Mag., 1871, VIII, p. 125, *f.n.*

Acanthodes, Dybowski, Mon. Zoantharia Scler. Rugosa, Pt. 1, 1873, p. 108.

„ Meyer, Schriften Physik-Ökonomis. Gesellsch. Königsberg, Abth. 1, 1881, p. 100.

Calophyllum, Schlüter (*non* Dana), Verhandl. Naturhist. Vereines Preuss. Rhein.-West., 1881, VIII (4), p. 190.

Pholidophyllum, Lindström, Bihang K. Sv. Vet. Akad. Handl., 1882, VII, No. 4, p. 63.

„ Lindström, *Ibid.*, 1883, VIII, No. 9, p. 12.

Cœlophyllum, F. Roemer, Lethæa Pal., 1883, I, Lief. 2, p. 409.

Cyathopedium, Schlüter, Abhandl. Geol. Specialkarte Preuss. Thüring. Staaten, 1889, VIII, Heft 4, p. 5 (263).

Tryplasma, Eth. fil., Rec. Geol. Survey N. S. Wales, 1890, II, Pt. I, p. 15.

Cœlophyllum, Weissermel, Zeitsch. Deuts. Geol. Gesellsch., 1894, XLVI, Heft 3, p. 634.

Pholidophyllum, Weissermel, *Ibid.*, p. 638.

Generic Characters (*emend.*).—Corallum simple, sub-compound, or sub-fasciculate. Corallites turbinate, cylindro-ob-conical, or simply cylindrical. Epitheca complete and concentrically lined, but not strongly developed. Wall always thin primordially, subsequently thickened with stereoplasma. Exothecal outgrowths consist of tubular radiciform processes, fistulæ, and "scales." Costæ absent, but rugæ always present, although never conspicuous. Bourrelets poorly developed. Septal apparatus strictly peripheral, of narrow, longitudinal, more or less parallel lamellæ, supporting free, upwardly-directed spines on their distal edges, and which may or may not be granulated laterally. Septal loculi, true dissepiments, and fossula absent. Calices where known, deep, and straight-walled within, or straight-walled below, and bell-mouthed above. Tabulæ complete or incomplete, very copiously developed; complete, extending entirely across the visceral chamber, and, in consequence of the brevity of the septal lamellæ occupying the greater portion of a visceral chamber, horizontal or variously inclined,

sometimes rolling; incomplete give rise to lenticular or wedge-shaped vesicles, true blister-cysts absent; tabulæ may, or may not, support longitudinal spines on their upper surfaces. Gemmation where known copious, simple or compound-calicular, and frequently rejuvenescent; possibly also parietal.

Tryplasma Lonsdalei, *Eth. fil.*

(Plate X; Pl. XI, Figs. 2–4; Pl. XII, Fig. 1; Pl. XIX, Fig. 4; Pl XXV, Fig. 5; Pl. XXVI, Figs. 1–7.)

Tryplasma Lonsdalei, Eth. fil., Rec. Geol. Survey N. S. Wales, 1890, II, Pt. 1, p. 15, t. 1.

Specific Characters.—Corallum of loosely aggregated to sub-fasciculate groups of corallites, sometimes forming large colonies, at least six inches in height. Corallites long, slightly flexuous, cylindrical, gradually increasing in size upwards to an average diameter of six millimetres, but attaining as much as eight, here and there united laterally either by fusion of their walls, or by fistulæ; bases pointed; length at least six inches. Epitheca delicate, concentrically lined, the lines crenulated on passing over the rugæ. Fistulæ well developed, usually more or less horizontal, present in all parts of the corallum, and only rarely passing from corallite to corallite on the same level; swollen at their junction with the corallites, and at times provided with a few septal spines; semi-fistulæ as knobs or small disconnected processes. Septal lamellæ narrow, forty to fifty in a cycle, primary and secondary; spines thorn-like, long, projecting inwards for about one-third the diameter of a corallite, from one to four cycles between tabulæ, but more commonly three, sometimes with lateral denticles. Tabulæ numerous and usually complete, generally regularly spaced apart, but here and there groups of close set floors, horizontal, oblique, or concave, often displaying a slight, central depression; incomplete vesicular tabulæ rare, but when present small, triangular and usually marginal. Gemmation compound-calicular-rejuvenescent, two buds immediately diverging from one another.

Observations.—This species must be regarded as the Australian type, as it was first described. It need not be mistaken for any other species except *T. vermiformis*; the distinctive features are referred to under the latter. The specific points of importance in *T. Lonsdalei* are:—

(1) Form of the corallum.
(2) Frequent occurrence and length of the fistulæ.
(3) Abundance of the septal lamellæ, size of the spines, and presence of lateral denticles.
(4) Grouping of the tabulæ.

The corallum is a large, sub-fasciculate and loose aggregation of long cylindrical corallites, either united by their lateral surfaces, or free and connected by fistulæ, which are seldom on the same level in contiguous tubes, although occasionally so. These fistulæ are enlarged at their junctions with the corallites, but contracted in their middle course, and do not appear to have any particular direction of curvature, although the horizontal predominates.

The corallites vary much in diameter, with eight milimetres as the approximate maximum width, and they are always wider at the offshoot of a fistula. Incomplete colonies only have been examined, but the corallites are known, even in their incomplete state, to attain six inches in length.

In my first description of this coral, I said regular accretion rings or bourrelets were absent. This was, however, an error; they are present in some examples, but weak and inequidistant.

The septal spines are highly developed and acicular, and the difference in size at once indicates the presence of primary and secondary lamellæ; lateral denticles are sometimes present.

The tabulæ are a very conspicuous feature in *T. Lonsdalei*, and are numerous in every corallite, the complete predominating largely over the incomplete. The clusters of closely packed tabulæ are a noteworthy and interesting detail. This is one of the forms with occasional depressions on the upper surfaces of the tabulæ, usually central, but sometimes excentric and then lateral; as I have already explained, these depressions are in no way of the nature of a fossula. Vesicular tabulæ do occur in *T. Lonsdalei*, but are small, marginal, and triangular in longitudinal section. The complete tabulæ immediately below a gemmiferous bifurcation are distinctly sigmoidal, and, adopting a term from Crinoid terminology, may be termed axillary. Oblique floors are not common as a rule, but one instance has come under notice in which the whole of them in five corallites, forming the section, are oblique, or oblique and rolling, or oblique and convex.

Gemmation has been observed but in few instances. The budding is certainly calicular, and may perhaps be parietal also; so far as I can ascertain, two buds only are given off from a parent corallite, and not four as in *T. dendroidea* and *T. vermiformis*; these branch obliquely from the parent, and present the appearance of a bifurcating stem. A specimen from the Sydney University collection exhibits a double bifurcation in the space of two and a quarter inches. It is possible that both parietal and calicinal gemmation

may occur in *T. Lonsdalei*, although I have not clearly seen the former. Nicholson says that in some cases compound calicular gemmation gives rise to fasciculate colonies,[1] and cites the Silurian *Cyathophyllum articulatum*, Wahl.,[2] as a case in point. "This peculiarity," he says, "is partly due to the fact that the secondary corallites remain cylindrical, without expanding materially; that they rise side by side without uniting, and without greatly diverging; and that their vertical growth is continued for a considerable period before they in turn give rise to calicine buds. Another cause for their fasciculate form is, however, to be found in the fact that in these cases true parietal gemmation is often combined with true calicinal budding."

The relation of *T. Lonsdalei* to *T. vermiformis* and *T. delicatula* is referred to in the descriptions of the latter species. Although *T.* (?) *Murrayi*, mihi.,[3] appears to be sub-fasciculate, the more intimate form of growth and that of the individual corallites is different. Of the four species described by Dybowski, only one (*T. tubulus*) is said to be fasciculate, and there are fistulæ also, but the septa in the two species differ widely.

Micro. Structure.—There is a thin proper wall, or theca, of dense structure presented either as a light or dark ring, usually the latter, followed by a moderate thickening of wavy, concentric stereoplasma; the structure of the fistulæ is precisely similar. The concentric laminæ of the thickened septal spines assume a cone-in-cone appearance. Thin sections also reveal another very interesting point in connection with these spines, viz., every here and there one or more sharp lateral denticles are seen to extend from the spines. These are very irregularly developed, as the transverse sections of some corallites exhibit none, whilst in others several spines are so provided. Another equally interesting point is that the mouths, or entrances into the fistulæ, are septal-spinose, and in one instance spines may be seen (Pl. XXVI, fig. 7) entering the tube itself. On the other hand, the tabulæ do not bear longitudinal spines as in *T. columnaris*, &c. It is not often possible, in one and the same section, to illustrate both the lamellar and spinose portions of a septum; in one section (Pl. XXVI, fig. 6), however, such is the case. On one side the corallite will be seen the more or less perfect organs, and on the other a series of rounded prominences which, I believe, represent the lamellar portions only.

[1] Nicholson—Trans. R. Soc. Edinb., XXVII, p. 249.

[2] See H. Milne-Edwards and Haime—Mon. Brit. Foss. Corals, Pt. 5, 1854, t. 67, f. 1.

[3] Etheridge—Geol. Survey Vict. Progress Rept., No. XI, 1899, p. 32, t. A., f. 1–3.

Localities.—Old Limekilns Ridge, Humewood, near Yass, County Murray (*R. Etheridge*—Mining and Geological Museum): Hatton's Corner, Yass River, near Yass (shales below limestone), County Murray (*T. W. E. David, W. S. Dun*—Mining and Geological Museum; *R. Etheridge, A. J. Shearsby, S. R. Mort*—Australian Museum): Portion 103, Parish Warroo, east bank of Yass River (shales below limestone), County Murray (*C. Cullen*—Mining and Geological Museum; *R. Etheridge*—Australian Museum): Derrengullen Creek, a branch of the Yass River, Parish Yass, County King (*C. A. Süssmilch*—Technical College, Sydney): Mudgee Road, five miles from Wellington (*C. Cullen*—Mining and Geological Museum): Two miles east of Pine Creek, Euchareena, Parish Trudgett, Wellington District, County Wellington (*J. Hook*—Mining and Geological Museum).

Tryplasma Lonsdalei, *var.* scalariformis, *var. nov.*

(Plate XII, Figs. 2 and 3; Pl. XIV, Fig. 4; Pl. XXIV, Figs. 7, 8, and 8A; Pl. XXV, Figs. 1–4; Pl. XXVI, Figs. 8–10.)

Observations.—In company with typical examples of *T. Lonsdalei*, we meet with other colonies possessing the same general structure as the latter, but which may be distinguished as follows:—

1. Although many of the corallites have the same average diameter as the species in chief, there is always a certain number of others surpassing the maximum measurement of the latter, and varying from eight to ten millimetres, and even attaining fifteen, just previous to a bud bifurcation. This imparts to the corallum in general a much more robust appearance, which is quite appreciable to the naked eye alone.
2. The tabulæ are, however, the important factor in distinguishing this variety. In the first place, so far as my sections show, there are no clusters of closely-packed floors; but the latter are, as a rule, far apart and equidistant, and, in their regularity, remind one of the rungs of a ladder, hence the varietal name.
3. There is also a slight difference in the gemmation, in that the young corallites are united laterally for some distance before springing from one another; two to four buds.

Fistulæ were present (Pl. XXV, figs. 1, 2, and 3).

In the regularity of its tabulæ, this variety is akin to *T.* (*Acanthodes*) *tubulus*, Dybowski, *T.* (*Amplexus*) *tortuosa* (Phill.), Kayser, and *T.* (*A.*) *borussicus*, Weissermel.

Localities.—Portions 29, 39, and 63A, Molong District, Parish Narragal, County Gordon (*C. Cullen*—Mining and Geological Museum): Portions 60 and 65, Parish Boree Nyrang, County Ashburnham (*C. Cullen*—Mining and Geological Museum): Mudgee Road, five and a quarter miles from Wellington (*C. Cullen*—Mining and Geological Museum): Portion 210, Parish Nemingha, County Parry (*C. Cullen*—Mining and Geological Museum): Anticline at Boambolo Crossing, Murrumbidgee River (*A. J. Shearsby*—Australian Museum): Mouth of Euralie Creek, Yass River, County Murray (*R. Etheridge, A. J. Shearsby*—Australian Museum): Horse-shoe Bend, Murrumbidgee River (*C. Jenkins*—Geological Department, University): Limestone Creek, Silverdale, near Bowning, County King (*J. Mitchell*—Mining and Geological Museum): McEwan's Creek, Jenolan Caves, and track near Guide's House, Mount Victoria Road, Jenolan, County Westmoreland, (*R. Etheridge*—Australian Museum).

Tryplasma Lonsdalei, *var.* minor, *var. nov.*

(Plate XVI, Figs. 3 and 4; Pl. XXIV, Fig. 9; Pl. XXV, Figs. 6 and 7; Pl. XXVI, Fig. 11.)

Observations.—The principal varietal character of this coral is in a diametrically opposite direction to that of the var. *scalariformis*—the corallites are smaller than those of *T. Lonsdalei* proper.

The corallum is formed of fasciculate masses of considerable size, closely imitating in its growth that of fascicular species of *Lithostrotion* and *Diphyphyllum*. The corallites do not exceed five millimetres in diameter, and vary between that measurement and four millimetres. The septal laminæ agree in number with those of the species in chief, but the spines are proportionately longer. There appears to be a complete absence of groups of close tabulæ, although the floors coincide in their distance apart with those of *T. Lonsdalei* proper. In general terms, its structure may be said to be that of the latter, but the corallites are of a decidedly smaller habit, and in consequence the colonies at once attract the eye of the collector in the field.

This variety is also more truly fascicular than the species in chief, and the corallites are clustered much closer together; in fact, in a large number of instances, they are actually united laterally. The fistulæ are also well developed, and form a prominent feature in weathered specimens (Plate XXVI, fig. 11).

I have not seen any trace of budding; at the same time, it must be fairly common to form the large masses constituting this coral.

Locality.—Banks of Yass River, Portions 53, 126, and 161 (shale below limestone), Parish Yass, County King (*R. Etheridge*—Australian Museum): Hatton's Corner, Yass River, near Yass (shales below limestone), County Murray (*C. A. Süssmilch*—Technical College, Sydney).

Tryplasma delicatula, *sp. nov.*

(Plate XXII, Fig. 9; Pl. XXIII, Figs. 6 and 7.)

Specific Characters.—Corallum loosely fasciculate, of unknown dimensions, but probably large. Corallites long, cylindrical, straight or slightly flexuous, from one and a half to three millimetres in diameter, united laterally by their walls, or by fistulæ. Fistulæ short, of less diameter than the corallites, horizontal, and placed at different levels. Septal lamellæ of two orders, primary and secondary, about thirty in a cycle; septal spines tooth-like, without lateral denticles, the secondary spines very short. Tabulæ complete and incomplete, the former at irregular distances apart, horizontal, concave, oblique or rolling, sometimes with a central depression, and at times provided with longitudinal spines; incomplete are vesicular, the vesicles triangular (in section), and marginal. Gemmation unknown.

Observations.—I do not feel justified in uniting this with *T. Lonsdalei*, although clearly of the same type, particularly of the var. *minor*. We have here a form not only with corallites of considerably less diameter and a much smaller habit, but also uniformly possessing thirty septal lamellæ, as against a considerable augmentation in *T. Lonsdalei* and its varieties. I was, further, always able to at once distinguish this species in the field, when *in situ* and in close contiguity to the former.

T. delicatula possesses the least number of septal lamellæ, in common with *T. vermiformis*, of any of our *Tryplasmæ*. I am not acquainted with anything like a perfect corallum, but judging from appearances, and its general resemblance to *T. Lonsdalei*, it must have grown to some size. The fistulæ are well developed for so fragile a form, and the septal spines are non-denticulate, but, as in *T. columnaris*, the tabulæ bear longitudinal spines.

Fistulæ have not been observed in *T. vermiformis*, nor vesicular tabulæ or tabular spines, the cut edges and ends of which are seen in thin transverse sections of *T. delicatula*, and notwithstanding the similarity in the same number of septal lamellæ, I believe the two corals to be distinct.

Locality.—Bank of Yass River, Portion 126 (shale below limestone), Parish Yass, County King (*R. Etheridge*—Australian Museum): Derrengullen Creek, a branch of the Yass River, Parish Yass, County King (*C. A. Süssmilch*—Technical College, Sydney.

Tryplasma vermiformis, *sp. nov.*

(Plate XI, Fig. 1; Pl. XXIII, Figs. 4 and 5.)

Specific Characters.—Corallum probably fasciculate and large. Corallites long, erect, cylindrical, straight, united laterally by their walls, or simply contiguous and separated by variable interspaces; section round, and diameter five millimetres. Epitheca apparently quite smooth. Bourrelets represented by a series of delicate, regular, equal rings of very low convexity, and following one another closely. Septal lamellæ twenty-eight to thirty, primary and secondary, and the separation distinctly marked; spines very delicate and acute, the secondary remarkably short. Tabulæ complete, distant, and regular, horizontal, very rarely slightly oblique. Gemmation compound-calicular-rejuvenescent, in two or four buds, the young corallites curving outwards from the parent.

Observations.—This remarkably simple form appears to be quite distinct from *T. Lonsdalei*, and worthy of a name. It is distinguished by—(1) the limited number of septa; (2) regularity and simplicity of the tabulæ; (3) apparent absence of radiciform processes and fistulæ.

The long, simple corallites seem to be quite smooth externally, the regular, equal, smooth bourrelets of low convexity giving to the tubes much the appearance of a worm, or caterpillar. I think the corallum must be described as fasciculate, for, although the specimens before me are, in a great measure, composed of fragments lying in all directions, still sufficient corallites remain in parallel and sub-parallel positions to indicate that the form of the corallum was that of large bundles as described, at least nine inches high by seven inches broad.

The septal lamellæ are less in number than in any other species, except one; and are remarkable for their well-defined separation into primary and secondary, as indicated by the length of the spines.

The tabulæ are very regular, almost always horizontal, spaced widely apart, and resemble the rungs of a ladder. In a transverse section the surface is always quite plain, without any trace of cut edges indicating the presence of irregular or vesicular tabulæ.

The method of budding in this species, of all our *Tryplasmæ*, more closely resembles that of *Pycnostylus*, Whiteaves, two or four buds. In Pl. XXIII, fig. 5, is a very beautiful example of the latter condition. Whiteaves remarks on the budding of *P. guelphensis* :—"Natural transverse sections of this species . . . . show a quadripartite, and more rarely a tripartite, division of the corallites. The appearance might be supposed to be the result of fission, rather than of calicular gemmation, but is really due to the coalescence of the inner walls of the corallites immediately after budding." Each bud in *T. vermiformis* is deltoid in transverse section, the four buds occupying the whole of the calice, the apices of the deltoids leaving a small free space between them in the centre (Pl. XXIII, fig. 5); each bud has already developed septa along its outer convex wall.

In many corallites the proper wall is very distinctly preserved as a thin dark circumferential line, with a narrow inner ring of stereoplasma. The same remark also applies to both the septa and tabulæ.

Locality.—Portion 9, Parish Boree Nyrang, County Ashburnham (*C. Cullen*—Mining and Geological Museum).

Tryplasma congregationis, *sp. nov.*

(Plate XIII, Fig. 1; Pl. XXI, Fig. 10; Pl. XXIII, Fig. 10.)

Specific Characters.—Corallum of sub-fasciculate masses of corallites connected by very numerous fistulæ. Corallites long, erect, cylindrical, sub-parallel, contiguous to one another or separated by various intervening distances, enlarging and contracting in their course; in section more often oval than round, with their longest diameter from ten to fifteen millimetres. Epitheca thin, and ornamented with delicate, equidistant, raised, encircling threads, here and there interspersed with thicker ones. Fistulæ very numerous, round or oval, usually more or less equally spaced apart, at distances of about ten millimetres, tier above tier, and on the same level in contiguous corallites. Septal laminæ about thirty-five, primary and secondary; spines delicate, non-denticulate, and remarkably short. Tabulæ complete and incomplete, but more often the former; complete—horizontal, oblique, or rolling; incomplete—as lenticular vesicles, broader at one end than the other. Gemmation in paired buds (?).

Observations.—The sub-fasciculate colonies are of no inconsiderable size, but the exact dimensions are unknown. The long cylindrical corallites

are generally closely packed, although at times separated from one another by intervals of some extent. They are either erect or a little curved, and, when clustered, are freely united to one another by numerous fistulæ, which seem to be developed at regular intervals, tier above tier (Pl. XIII, fig. 1), and practically on the same level throughout the corallum.

The points chiefly relied on for specific separation are:—(1) Small number of the septal laminæ, and brevity and delicacy of the spines; (2) plentitude and regularity of the fistulæ.

When compared with some other species of this genus, the tabulæ present a far more regular appearance than most, with the exception of those of *T. columnaris* and *T. dendroidea*, which resemble them. This is one of the species in which the tabulæ, when viewed from above, exhibit the peripheral nicks, the impressions of the septal spines.

The gemmation is not fully known; two buds were certainly developed at one and the same time, but whether or no these were all, I am unable to say.

Microscopic sections reveal the presence of a very thin theca, visible only in well-preserved specimens, with a narrow stereoplasmic lining, which completely invests the laminæ, and coats the primordial spines. Here and there the latter thickening has the usual delicate cone-in-cone structure; but, in other instances, it is like the stereoplasmic wall lining, grey in colour, and structureless.

Localities.—Derrengullen Creek, a branch of the Yass River, and Barber's Creek, a branch of Derrengullen Creek, near Bowning, County King (*A. J. Shearsby*—Australian Museum; *C. A. Süssmilch*—Technical College, Sydney).

Tryplasma columnaris, *sp. nov.*

(Plate XV, Figs. 6; Pl. XIX, Fig. 5; Pl. XXIV, Figs. 2–5.)

Specific Characters.—Corallum in the form of solitary corallites, so far as known. Corallites long, columnar-cylindrical, straight or sometimes slightly curved, attaining a diameter of twenty-five millimetres; base obtusely pointed. Epitheca ornamented with fine, concentric, close, wavy lines. Rugæ in the form of obtuse rounded ridges. Bourrelets as fine concentric rings, the edges crenulated by the rugæ, irregularly spaced apart, but often close, sometimes developing into obtuse swellings rendering the

surface of a corallite uneven. Septal lamellæ strongly developed, sixty to eighty in number, primary and secondary; spines non-denticulate, the primary long and acicular, extending well on to the surfaces of the tabulæ, secondary spines short and thorn-like. Tabulæ numerous, close, complete, but more commonly incomplete, the former rolling, the latter forming lenticular vesicles; spines freely developed on the upper surfaces of the tabulæ. Gemmation unknown.

Observations.—*T. columnaris* is remarkable as being one of the three corals possessing spines on the tabulæ, a feature which at once separates it from the other species having a similar external appearance. In horizontal sections the spines are visible, either as dark spots scattered over the surface or as dark rings with a refractive centre.

Detached pieces of this coral, on external characters only, may easily be mistaken for large examples of *T. dendroidea*, but its highly lenticular vesicular tabulæ and spines will at once separate them.

The microscopic structure is interesting. The theca is, as usual, indicated by a thin dark circle, and within this is a stereoplasmic layer of variable width, although usually wide, and enveloping the septal spines unequally in different specimens. Some it encases in a uniform manner, rendering them obtuse; in others the stereoplasma accommodates itself to the outline of the spines, following their acicular form. This stereoplasma may be either homogeneous and structureless, or with the usual wavy cone-in-cone appearance. The spines on the tabulæ are similarly invested.

Localities.—Portion 4, Parish Boree Nyrang, County Ashburnham (*C. Cullen*—Mining and Geological Museum): Boree Creek, Portion 2, Parish Cudal, County Ashburnham (*C. Cullen—Ibid.*): Quedong, County Wellesley (*C. Cullen—Ibid.*).

Tryplasma, *sp.*

(Plate XIII, Fig. 2.)

Observations.—I am unable to refer these long corallites to either *T. congregationis*, *T. columnaris*, or *T. dendroidea*. From external appearance only it might easily be placed with the second, but my sections, which are not all that could be desired, do not show the presence of spines on the tabulæ, and there is no trace of gemmation; also, its close entombment in the matrix renders a detailed examination very difficult. The specimen consists of two

long, pipe-like corallites, one ten inches in length, retaining much the same diameter throughout. If the spines on the tabulæ are not to be regarded as a specific point in *T. columnaris*, these corallites might then be included in that species from the want of evidence to the contrary.

Locality.—Portion 77, Parish Eurimbula, County Gordon (*C. Cullen*—Mining and Geological Museum).

Tryplasma dendroidea, *sp. nov.*

(Plate XIV, Fig. 1; Pl. XV, Fig. 5; Pl. XVIII, Figs. 2–6; Pl. XIX, Fig. 6; Pl. XXII, Figs. 11–15; Pl. XXIII, Fig. 9; Pl. XXIV, Fig. 6; Pl. XXVII, Figs. 3 and 4.)

Specific Characters.—Corallum consisting in the first instance of single corallites, which, by repeated quadripartite gemmation, give rise to a modified form of dendroid growth. Corallites long, cylindrical, erect, or slightly curved, with an average diameter of twelve millimetres, increasing to fifteen or even twenty immediately previous to budding. Epitheca ornamented with fine concentric line-ridges, close, with here and there a coarser one. Fistulæ seldom developed. Septal lamellæ fine, about fifty-five, primary only; spines thorn-like, short, very fine. Tabulæ complete, at variable distances apart, horizontal or convex, forming plane, solid floors on natural fracture; vesicular tabulæ very exceptional. Gemmation very marked and persistent, four rejuvenescent buds in opposite pairs, rapidly diverging from one another.

Observations.—The corallum of *T. dendroidea* assumes a more definitely dendroid form of growth than that of any other of our Australian species. It appears to consist of one (Pl. XVIII, figs. 2–4) or more long corallites in juxtaposition but separate, seldom ever united by fistulæ, increasing at intervals by the usual calicinal rejuvenescent budding in bunches of four, giving rise to a series of young corallites free laterally, conveying to the whole a peculiar and modified form of dendroid growth, but how frequently this takes place in a corallum I have no evidence to show.

The complete or greatest length attained by any one corallite is unknown, but in one instance (Pl. XVIII, fig. 3) the incomplete parent stem is seventy-five millimetres in length. It is, however, quite clear that the distance between points of gemmation varied considerably, for the offspring is but thirty millimetres long before it commences to again reproduce.

In consequence of the usually complete nature of the tabulæ, fracture across the stems easily takes place, and it is not uncommon to collect the coral

as a number of comparatively small discs, the latter representing one or more of the old visceral chambers. Another important feature is the plane even surface of the tabulæ on fracture, arising from the shortness of the septal spines. This character *T. dendroidea* bears in common with *T. congregationis*; indeed it is, in many ways, closely allied to the latter, and, had it not been for the marked development of the fistulæ, lesser number of septal lamellæ in a cycle, and presence of vesicular tabulæ in the latter, I would have felt inclined to unite the two forms.

I am not acquainted with the mode of reproduction in *T. columnaris*, but, over and above this, the present species is separated from that coral by the regularity of its tabulæ, the absence of accretion ridges to any degree of importance, and generally less robust appearance.

The principal characters of *T. dendroidea* are:—(1) Mode of growth; (2) preponderance of complete tabulæ; (3) extent of surface of the latter on fracture.

T. (*Amplexus*) *stigmatophorus*, Sandb.fr.,[1] from the Devonian of Nassau, is probably allied here, having the same large complete tabulæ, with peripheral septal spine impressions.

Localities.—Derrengullen Creek, a branch of the Yass River, Portion 10, Parish Yass, County King (*C. Cullen and W. S. Dun*—Mining and Geological Museum; *A. J. Shearsby*—Australian Museum): Barber's Creek, a branch of Derren-gullen Creek, Parish Yass, County King (*A. J. Shearsby*—Australian Museum.

Tryplasma derrengullenensis, *sp. nov.*

(Plate XXII, Figs. 5–8.)

Specific Characters.—Corallum simple. Corallites solitary, small, turbinate, ob-conical, or elongate and twisted, irregularly undulated in consequence of the unequal development of bourrelets. Radiciform processes well developed, always on one side a corallite more than the other, clustered. Epitheca complete, ornamented by scalloped encircling lines. Rugæ broad. Bourrelets prominent for so small a species, representing the margins of pre-existing corallites. Calice deep, nearly straight-walled; floor flat. Septal lamellæ very numerous and short, primary and secondary, the former leaving deep furrows in casts, the latter shallow; spines thorn-like, the primary much larger than the secondary, one to two cycles in old visceral chambers, and

[1] Sandberger, fr.—Verstein. Rhein. Schich. Nassau, Lief. 8, 1854, t. 36, f. 14*b*.

very numerous and close set one above the other in the calice. Tabulæ complete, at irregular distances apart, but on the whole close set, horizontal or slightly oblique, bearing longitudinal scattered spines. Gemmation compound, four calicular-rejuvenescent buds; budding may commence at a very early stage.

Observations.—A very interesting little species, the smallest of our *Tryplasmæ*. The remarkable depth of the calice (Pl. XXII, fig. 6) is only equalled by the number of septal spine cycles. There appear to be more secondary than primary cycles, twelve cycles of the former and ten of the latter. The complete tabulæ are so closely set that not more than one or two cycles could have existed in each old visceral chamber or intertabular space. The upper surfaces of the tabulæ are minutely spined, and the spines irregularly scattered; this is the third Australian species possessing these interesting structures.

Radiciform processes are confined to one side of a corallite, leading to the belief that in the living state the coral was inclined from the vertical.

The bourrelets are a prominent feature in *T. derrengullenensis*, giving an irregular, highly crinkled outline to the corallites. Their margins are delicately festooned by the fine epithecal lines passing over the rugæ, in a measure resembling the European *T. tubulatum*.

This, of all our Australian species, approaches nearest in outward form to the European *T.* (*Pholidophyllum*) *tubutatum*, Schl., and also to *T.* (*Acanthodes*) *rhizophorus*, Dyb., and *T.* (*A.*) *Eichwaldi*, Dyb. If Lindström is correct in referring *Cyathophyllum radicula*, Rominger, to his *Pholidophyllum*, it also may possibly prove to be nearly allied to *T. derrengullenensis*.

Locality.—Limestone Creek, near Bowning, Parish Derrengullen, County King (*A. J. Shearsby*—Australian Museum; *W. S. Dun*—Mining and Geological Museum).

Tryplasma wellingtonensis, *Eth. fil.*

(Plate XVI, Figs. 5–10; Pl. XXI, Figs. 11 and 12; Pl. XXII, Figs. 2–4.)

Tryplasma wellingtonensis, Eth. fil, Rec. Geol. Survey N. S. Wales, 1895, IV, Pt. 4, p. 160, t. 21–22.

Specific Characters.—Corallum in the early stages simple and solitary but by repeated calicinal gemmation in single buds forming strings of corallites. Corallites turbinate, or turbinate-conical when young, becoming more cylindrical in advanced growth, and sometimes twisted or bent upon

themselves; section circular; bases of parent corallites pointed, or expanded. Radiciform processes occasionally developed, long, stout. Bourrelets feebly developed, but represented chiefly by the projecting margins of old calices. Calice deep and straight-walled, non-expanding or bell-mouthed. Septal lamellæ about fifty in number, of two orders, primary and secondary, the former short; primary spines well developed, thorn-like, not laterally curved, and without lateral denticles; secondary spines as mere tubercles on the free edges of the secondary lamellæ. Tabulæ very numerous, complete or incomplete; the former delicate, close or widely separated, horizontal, oblique, or rolling; incomplete forming wedge-shaped, irregular, or lenticular vesicles. Gemmation single, calicinal or calicino-marginal, the former at once filling the parent calice, the latter springing from the edge of the parent calice by an attenuated base; in either case continuing in the same plane as the parent, or immediately diverging therefrom.

Observations.—This species is a characteristic coral of the Wellington Cave Limestone, and is interesting as presenting some very instructive examples of calicinal gemmation in single buds.

The corallites of *T. wellingtonensis* are always simple and solitary in the first instance, and do not give rise to sub-composite bunches even to the same degree as *T. princeps*, but by ordinary calicinal budding produce single lines of successively developed individuals, but to what extent this was carried on there is no evidence to show. As the corallites increased in growth, they took on a more cylindrical and less turbinate appearance, corallites here and there becoming twisted, or even bent on themselves. The base of the original, or first corallite, is either pointed obtusely or expanded, as if forming a base of attachment; there are no fistulæ. Bourrelets, or accretion rings, are represented by the edges of old calices where a younger corallite has grown rapidly within, possessing much the same diameter as the parent, and thus completely infilling it. At times a small peripheral space is left between the two, in which the tooth-like septal spines are just visible. The deep and straight-walled calice does not appear ever to expand as in *T. liliiformis*. The bottom is usually uneven, from the rolling nature of the tabula forming it.

No opportunity having arisen of examining an absolutely unoccupied or perfect calice, the precise number of septal lamellæ is still an open question; but judging from several computations, the total complement must have been fifty, more or less. There is a marked difference between the

primary and secondary lamellæ in that the former extend further inwards than do the latter, so much so that the secondary spines appear almost as if perched directly on the thickened wall, and are more of the nature of granules. On the floor of the open calice the lamellæ appear to "tail off" and become lost, and the spines and granules are perched directly on the floor itself, extending some distance towards the calice centre.

The numerous tabulæ are "thin and delicate, close together, or widely separated, complete or incomplete, horizontal or oblique, either extending wholly across the corallum or coalescing with one another, and in the latter case enclosing irregular or subvesicular, intertabular spaces."

The budding falls within that section termed by Nicholson "simple calicular gemmation." On this he remarked:—"In what is usually understood by calicular gemmation, the oral disc of the primitive polyp produces two or more buds; these in turn repeat the process, and ultimately we have a mass of an inverted pyramidal shape, composed of numerous corallites diverging from the base. In the particular mode of growth to which I propose to apply the term of '*simple*' calicular gemmation, there is a well-marked modification of the above. The corallum, originally simple, after growing to a certain extent, sends up from its oral disc a *single* bud. The primitive calice may or may not be more or less completely obliterated by the gradual growth and extension of the epitheca over it; and the secondary bud may or may not produce a tertiary bud in the same manner as that in which it was itself produced. In any case, the mode of increase is by the production of single buds from the calicine disc, and consequently the resulting form of the corallum is in all cases altogether different to what is seen in the ordinary method of calicular gemmation."[1] This takes place precisely in *T. wellingtonensis*. A calice is (Pl. XVI, fig. 5) or is not (Pl. XVI, fig. 6) filled by a new corallite, the secondary bud producing a tertiary, and so on. As examples of simple calicular gemmation, Nicholson cites the Devonian *Cystiphyllum squamosum*, Nich., *C. ohioense*, Nich., and *C. vesiculosum*, Goldf., the last of these presenting a remarkable resemblance to some conditions of *T. wellingtonensis*. Another point of similarity between the latter and these older well-known species may be again expressed in Nicholson's words:—"The old cups are usually quite distinct; but they may be more or less completely obliterated by the gradual growth and extension of the epitheca over them. In these cases, it becomes sometimes

[1] Nicholson—Trans. R. Soc. Edinb., XXVII, p. 238.

difficult to distinguish the remains of the old cups from particularly strong and well-marked 'accretion ridges.' There is, however, strong reason for believing that the production of accretion ridges, and the simple form of calicular gemmation just alluded to, are merely different stages of the same physiological process." This explanation can be appreciated by a glance at (Pl. XVI, figs. 5 and 6.)

Sections prepared for the microscope reveal the presence of a thick and dark-coloured outer wall, inwardly invested by an ample stereoplasmic layer, which also follows the septal spines, and, in fact, at times represents them, without the presence of primordial laminæ.

On the question of dissepiments, I formerly wrote as follows[1] :—" In a coral with such remarkably short and distally free septa, dissepiments would not be expected, but at times a single dark plate is developed. . . . It is, in all probability, not formed by a series of dissepiments in a single line, but is the primitive theca in the substance of the outer investment, and septa traversing this zone have an intra- and extra thecal portion. In a rather more complete section . . . . an inner ring is visible which might be taken for a further series of dissepiments; it is, however, a second corallite springing from within the older one."

The principal characters relied on to distinguish this species are—(1) form of the corallites; (2) marked distinction between the two orders of the septal lamellæ; (3) simple calicinal gemmation; (4) non-expansion of the calice edge.

Locality.—Wellington Caves, near Wellington, County Wellington (*J. Sibbald*—Mining and Geological and Australian Museums).

Tryplasma, *sp.*

(Plate XVI, Figs. 1 and 2; Pl. XXII, Fig. 16; Pl. XXIII, Fig. 8.)

Observations.—The subject of the above figure appears to be allied to *T. wellingtonensis,* but still presents an important point of difference. The corallum evidently consisted of an aggregation of corallites produced by repeated budding, which was, I think, calicinal, notwithstanding the deceptive parietal appearance of the two corallites, one above the other, in the left central line; the three buds at the lower left-hand corner appear to be calicinal also. The septal apparatus consists of stout vertical laminæ,

[1] Etheridge—Rec. Geol. Survey N. S. Wales, 1895, IV, Pt. 4, p. 162.

and short, blunt spines, forty-five to fifty in number, and all of one order. Some of the corallites were also connected by large fistulæ; another very striking feature lies in the complete and, at times, widely separated tabulæ.

Some aspects of the growth of this coral recall the structure of *T. wellingtonensis*, but, on the other hand, the corallites of the latter are not, so far as known, aggregated into masses. The tendency of the calice to expand reminds us of the appearance of *T. liliiformis*. For the present, the identity of this coral must remain in abeyance.

Locality.—Geurie, near Wellington, County Lincoln (*W. Anderson* and *P. T. Hammond*—Mining and Geological Museum).

Tryplasma (?) Murrayi, *Eth. fil.*

(Plate XXVIII.)

Tryplasma Murrayi, Eth. fil., Geol. Survey Vict. Progress Report, No. XI, 1899, p. 32, t. A., f. 1–3.

Specific Characters.—Corallum consisting of bundles or bunches of corallites, the precise ultimate growth unknown. Corallites of vigorous growth, long (up to four inches), cylindrical, straight, or a little curved, often partially united externally by their walls, and with a maximum diameter of half an inch. Wall much thickened by secondary deposit. Epitheca delicate, the lines very close and wavy. Fistulæ and radiciform processes not observed. Bourrelets irregularly developed, rendering the corallite surfaces uneven. Rugæ flat, separated by grooves indicating the peripheral ends of the septal lamellæ. Calices deep and straight-walled Septal lamellæ very numerous, about fifty, narrow, apparently of one order only; septal spines very numerous, short, and stout. Special endothecal tissue present as one or two cycles of dissepimental cells. Tabulæ unknown. Gemmation apparently calicinal, in single buds.

Observations.—Through the courtesy of the Secretary for Mines and Water Supply, Melbourne, I have been able to restudy the type specimens of this species, supplemented by additional material. Prof. W. Baldwin Spencer, Director of the National Museum, has also sent me a fine example from Waratah Bay. The result of this re-examination is the foregoing amended description, but even this is imperfect from the fact that through the absence of sections prepared for the microscope I am unable to study several important points of structure.

It is, however, necessary to explain that I now know my original description of *T.* (?) *Murrayi*, included two distinct corals. Although suspected for some time, I only became convinced of this on receiving the National Museum specimens. In each of the examples from the Geological Survey collection the larger corallites (*T.* (?) *Murrayi* restricted) are intermingled with a number of much smaller, more or less irregular tubes; these I took to arise from the larger corallites as the result of repeated parietal budding, more than one apparent junction being present. The specimen from the National Museum is free of this second coral, and after a long and tedious examination I find that the internal structure of these tubes is purely cystoid-vesicular. I, therefore, restrict the name *T.* (?) *Murrayi* to the larger cylindrical corallites.

Whilst possessing one of the most important and essential characters of *Tryplasma*, the large corallites depart from the structure or typical members of the genus by the presence of peripheral endothecal tissue in the form of from one to two cycles of calcareous plates passing from one septal lamella to the next one, and apparently (so far as my limited opportunity for examination has gone) enveloped, like the septal spines, with the exception of the actual apices, in a remarkably thick secondary investment. These transverse plates are faintly visible in the only section (imperfect) I have been able to prepare for the microscope (Pl. XXVIII, figs. 3 and 7), but on the weathered surface of a corallite (Pl. XXVIII, fig. 5) they are much more apparent, and are again seen in a semi-vertical natural section of a portion of a wall (Pl. XXVIII, fig. 6). The close resemblance of these plates to dissepimental tissue cannot be denied, although the tissue generally is scanty. It introduces an element of structure unlike that of any other member of the genus.

It is difficult to arrive at the precise mode of growth in *T.* (?) *Murrayi*, but the corallites would appear to form more or less sub-compound bunches, the individual members here and there close enough together to become united to one another for some portions of their course by their walls. Some of the old calices present a double wall on fractured transverse surfaces, as if one corallite had sprung up within the other. It would appear from this that we have here true calicinal budding.

The septal apparatus of *T.* (?) *Murrayi*, is strictly on the lines of *Tryplasma*, marginal longitudinal lamellæ distally produced into spines. The lamellæ were very numerous, the spines in the calices densly packed,

and in the only naturally fractured longitudinal section exposed, although the sides of the corallite in question are crushed together (Pl. XXVIII, fig. 4), the presence of the spines is shown throughout. I am unacquainted with the nature of the tabulæ.

The largest specimen is a cluster of corallites six and a half inches by three and a half inches, the longest individual corallite seen measuring four inches.

It is almost needless to remark that the structure of *T.* (?) *Murrayi* does not strictly conform to the generic characters embracing the whole of the typical species; it is, therefore, an altogether aberrant form of *Tryplasma*.

The species is named in honour of Mr. R. A. F. Murray, formerly Government Geologist of Victoria.

Locality.—Waratah Bay, near Wilson's Promontory, S.E. Victoria (*Geological Survey of Victoria and National Museum Collections, Melbourne*).

Tryplasma liliiformis, *sp. nov.*

(Plate XIV, Figs. 2 and 3; Pl. XV, Figs. 2–4; Pl. XVII, Figs. 7 and 8; Pl. XXIV, Fig. 1; Pl. XXV, Fig. 8; Pl. XXVII, Figs. 1 and 2.)

Specific Characters.—Corallum aggregate, hardly sub-compound, nor strictly fasciculate. Corallites liliaciform, stem-like below, with a diameter of five-eighths of an inch, expanding above into bell-shaped calices, two and a half to three inches in diameter; base sometimes pedunculate. Proper wall narrow. Epitheca delicate, thin. Rugæ flat. Radiciform processes long and well developed, irregularly scattered on the stems or basal portions of each corallite, and sometimes to be seen immediately below the calice margins. Calices wide and bell-mouthed, deep, with the bottoms flat or slightly concave. Septal lamellæ very numerous, mere ridges, about fifty-eight in the stems and eighty in the calices, primary and secondary; spines short and blunt, horizontal or slightly projecting upward. Tabulæ very numerous, complete and incomplete; complete tabulæ horizontal, concave, or rolling, close in the stem, but much wider apart near the calice; incomplete forming long, large, and often irregularly lenticular vesicles. Gemmation compound-calicular-rejuvenescent, two to three (? four) buds.

Observations.—The corallum of *T. liliiformis* is never compound in the strict sense of the word, nor can it be described as fasciculate, but the corallites appear to be aggregated into loosely constructed colonies. The corallites are remarkably persistent in form, resembling the calyx of a liliaceous plant on a stem. They are more or less erect, sub-parallel, and not twisted or tortuous. The radiciform processes are freely developed and often long (Pl. XIV, fig. 3; Pl. XXVII, fig. 1), for, irrespective of those attached to corallites, the surfaces of matrix hand-specimens are dotted with numerous portions and cross-sections of these rootlets; fistulæ proper appear to be absent.

The bell-mouthed calices are deep, in a few examples very deep, and in their lower portions straight-walled within. No other species of this genus appears to possess this form of calice so distinctly marked. Some of the bell-mouths attain to two and three quarter inch in diameter (Pl. XXVII, fig 1).

The greatest number of septal lamellæ counted in the calices is eighty, but in the stem-like portions the number is less. The difference in length of the primary and secondary spines is but slight; neither curved spines nor lateral denticles have been observed.

The tabulæ are very numerous, the complete floors regular as a rule, often wide apart, and not spined. When the plane of a cycle of septal spines is coincident with that of a tabula, peripheral nicks are left on natural transverse fracture. The vesicles formed by the incomplete tabulæ vary much in shape when seen in longitudinal section, but the elongate lenticular outline predominates.

In a transverse section prepared for the microscope, the proper wall when preserved appears as a thin dark circle, with an inner zone of wavy stereoplasma encasing the septal laminæ. In a longitudinal section the primordial line of the tabulæ is sometimes visible, and there is always a secondary thickening of greater or less extent; the stereoplasma of the wall and that of the tabulæ are one, and continuous without a break, but that of the wall investment is distinctly wavy and that of the tabulæ laminar.

T. liliiformis possesses some characters in common with *T. wellingtonensis*, but the following points will separate them:—(1) The Wellington species does not possess the same stem-like prolongation; (2) the calices are not bell-mouthed; (3) Gemmation is by single buds only; (4) the young corallites at once become turbinate, or some slight modification of this; (5) the distinction between the primary and secondary septal spines is very marked.

At first sight, the stem-like portion of the corallites, and the long corallites of *T. dendroidea* would appear to be one and the same. There is, however, this marked difference :—In the former the tabulæ are almost always crowded together, irregular, and, more often than not, vesicular, whilst the tabulæ of the latter are conspicuous by reason of their comparative regularity, horizontality, and rare vesicular nature. I freely confess I was for a long time in doubt how closely these forms were related to one another, for in *T. liliiformis* the bell-mouthed calices are supported with stem-like continuations of unknown length resembling the corallites of *T. dendroidea*.

The points relied on for specific separation are chiefly :—(1) Form of the corallites ; (2) copious development of radiciform processes.

Of European species, *T.* (*Calophyllum*) *curycalyx*, Weissermel, is very closely allied here, both in the form of the calyx and method of budding.

Localities.—Hatton's Corner, Yass River, near Yass, County Murray (Geological Department, University) : Derrengullen Creek, a branch of the Yass River, Portion 10, Parish Yass, County King (*C. Cullen*, *W. S. Dun*, and *A. J. Shearsby*—Mining and Geological Museum ; *A. J. Shearsby*—Australian Museum) : Barber's Creek, a branch of Derrengullen Creek, Parish Yass, County King (*A. J. Shearsby*—Australian Museum) : North-east corner of Portion 103, Yass River, Parish Warroo, County Murray (*R. Etheridge*—Australian Museum) : Seven miles west of summit of the Canoblas Range, near Orange, County Ashburnham (*J. M. Curran*—Australian Museum) : Parish Barton, County Ashburnham (*C. A. Süssmilch*—Technical College, Sydney).

Tryplasma princeps, *sp. nov.*

(Plate XV, Fig. 1 ; Pl. XVII, Figs. 1–6 ; Pl. XVIII, Figs. 1 and 7 ; Pl. XIX, Figs. 1–3 ; Pl. XX ; Pl. XXI, Figs. 1–9 ; Pl. XXII, Figs. 1 and 10 ; Pl. XXIII, Figs. 1–3.)

Specific Characters.—Corallum consisting of simple solitary corallites, ultimately forming, by repeated budding, sub-compound masses or bunches. Corallites cylindrical to cylindro-ob-conical, large, stout, straight or rather curved, expanding slowly upwards from a more or less pointed base, attaining a length of at least eleven inches, by two and a half inches in transverse diameter ; section circular or oval. Epitheca ornamented by close, encircling lines. Radiciform processes well developed, large, but irregularly distributed,

chiefly present on the basal half of each corallite, single or in groups. Fistulæ present in the rejuvenescent corallites only. Rugæ fine. Calice deep and large, nearly straight-walled within. Septal laminæ stout and strong, sixty-five to eighty, barely differentiated into primary and secondary; spines practically of one length, short, stout, occasionally laterally curved, but not denticulated. Tabulæ highly developed, at very irregular distances apart, sometimes much crowded together, complete and incomplete; complete tabulæ are horizontal or oblique, but more often rolling; incomplete tabulæ forming vesicles, either short and deep, and extending but a short distance from the wall, or elongately lenticular, and reaching nearly across the entire corallite; longitudinal spines absent. Gemmation compound-calicinal-rejuvenescent, copious, marginal or intra-marginal, and apparently only taking place in the gerontic calyx; buds at least thirteen, laterally united or connected by fistulæ.

Observations.—The corallites of *T. princeps* vary from cylindrical to cylindro-ob-conical, *i.e.*, a form varying between cylindrical and an elongate reversed cone (Pl. XVII, fig. 1; Pl. XX, fig. 1). The corallites are straight or gradually curved, and, in the latter condition, closely resemble in external appearance the large *Campophyllum giganteum*, Michelin, of the European Carboniferous Limestone. The upward expansion is slow, and proceeds from a more or less obtusely-pointed base. The large radiciform processes at the bases are a very prominent feature, represented by their wart-like broken bases, occurring singly or in groups. At Pl. XVII, fig. 1*c*, will be seen a long process flattened against the side of the corallite and below the bud. I am undecided whether to regard this as a part of a very long radiciform process, or as a fistula; if of the latter nature it is the only instance in the mature state of this species.

The septal laminæ are very numerous, and, so far as my sections reveal, do not appear to vary materially in number in different parts of the corallum. The septal spines are strongly developed, and sometimes laterally curved. The separation into primary and secondary is very arbitrary; in some instances (Pl. XVII, fig. 5) it is clear enough, in others it is quite lost, or it may appear in one portion of a corallite, and not in another; this separation seems to be influenced by the amount of stereoplasmic thickening present. As a rule, there is one cycle of spines in each old visceral chamber, or inter-tabular space; but, in rare instances, where the tabulæ are distant from one another, two, or even three cycles have been observed.

One marked feature in this coral is the irregularity of the tabulæ, both in their distance apart and in development.

Compound calicular budding is very prolific in *T. princeps*, and takes place either from the calice margin of the mature corallite, or is intra-marginal, the new corallites soon becoming detached from one another, except that fistulæ are sometimes seen to connect them. In the cylindrical specimen represented in Pl. XVII, fig. 1, there is one large bud; in portions of two other similar specimens, six are apparent. In a smaller ob-conical individual (Pl. XX, fig. 4), there are no less than thirteen young corallites, ten of them actually marginal, and the other three intra-marginal. In Pl. XVIII, fig. 1, are represented the two united portions of a really fine example of gemmation, the basal half consisting of three ob-conical corallites (Pl. XIX, fig. 1), of which the largest is seen to be giving off seven still younger individuals, five marginal and two intra-marginal. In the lower transverse view of the upper half (Pl. XIX, fig. 2), thirteen corallites are visible, including the seven already mentioned, the remaining six having budded above the level of the fractured half. The upper or growing surface of this group (Pl. XIX, fig. 3), displays twelve well-developed corallites, the thirteenth having been crowded out.

On the subject of compound calicular gemmation, so beautifully displayed in this corallum, Nicholson says:—"The primitive corallite throws up from its calicine surface two or more buds, which, after reaching a certain size, in most cases repeat the process. . . . . The necessary result of this is, that the aged corallum assumes the form of an inverted pyramidal mass, the base of which is formed by the primitive corallite. From the calice of this the secondary corallites diverge, and the surface of the entire mass is flattened or slightly convex. The calices of the secondary corallites, and the corallites themselves, may remain more or less completely separate. . . . . At other times the corallites are more intimately united by their walls, and the corallum becomes truly astræiform."[1] This paragraph admirably expresses the condition in *T. princeps*, except that not only are the younger corallites connected by their walls for a short length, but at times also by fistulæ.

It is difficult to imagine that the small buds represented in Pl. XX, fig. 4, could ever attain anything approaching even moderate dimensions as compared with the more highly vigorous parent. Nicholson has suggested

[1] Nicholson—Trans. R. Soc. Edinb., xxvii, p. 239.

an explanation of this, as follows :—"In this modification, the calice of the primitive corallite throws up a number of buds; but the former does not seem to feel the stimulus to gemmation till it has reached a great age, and a corresponding size. The result of this is, that the secondary corallites remain more or less aborted, and do not appear to have sufficient energy to repeat the process of budding. Hence, in these cases, we have the fully developed, and often comparatively gigantic parent corallite, surmounted by a tuft of small undeveloped secondary corallites, springing from different points on its calicine surface." [1]

In a horizontal section prepared for the microscope, the external wall appears as the usual dark circumferential line, sometimes with an inner zone of secondary stereoplasma, and sometimes without; the latter, when present, is bounded inwardly by a thin dark ring, which possibly represents the primitive theca. If this be so, there is then an intra- and extra-thecal portion; the wall stereoplasma is grey in colour, homogeneous, and dense. The supposed primitive theca is, more often than not, absent when the septal lamellæ abut against the external wall. These lamellæ may, or may not, consist of primordial septa, represented by dark rods, surrounded by stereoplasma, having a feathery cone-in-cone structure, and projecting a short distance into the visceral chambers; each cone-in-cone mass is separated from its neighbour by a thin fluctuating line. In the absence of the primordial septa, the surrounding stereoplasma and the fluctuating boundary lines are present all the same. The spines also differ in the same section; they may be short, blunt, and triangular, forming a serrated edge to the stereoplasmic ring, or a series of definite short spines.

In a longitudinal section the eye is at first attracted by the thickness of the wall stereoplasma, intersected by an occasional primordial septum. It will be observed that some of the free ends of the spines are upwardly turned, or hooked. The primordial tabulæ and their stereoplasmic thickenings are also plainly visible.

Pl. XXI, fig. 3, represents a section cut longitudinally and somewhat obliquely through the septal lamellæ immediately before becoming spinous; the primordial septa are distinctly visible. At first sight, these would appear to be dissepiments; but I regard these transverse lines as the cut ends of tabulæ only.

[1] Nicholson—Trans. R. Soc. Edinb., xxvii, p. 240.

The structure of the radiciform proecsses is eoncentrie (Pl. XXII, fig. 10).

I have included under *T. princeps* what might, at first sight, appear to be two distinct eorals, looking at the outward form only. As far as my examination has gone, all, however, possess a similar internal strueture. We see, in the first instance, the long cylindrical *Campophyllum*-like eorallum (Pl. XVII, fig. 1), abruptly ending below in a mueh contracted and insignificant base, and bearing one bud above on the ealcine margin. The next step in advance are the two corals (Pl. XX, figs. 3 and 5), each giving off six buds, the naturally-weathered longitudinal section (Pl. XX, fig. 2), and the spine-pitted speeimen (Pl. XV, fig. 1). We may now turn to the subjects of Pls. XVIII, fig. 1; XX, figs. 1 and 4. At first sight these more elegantly shaped and rather ob-conical forms eonvey the impression of a distinct species, but, as already stated, the inner structure is the same as the cylindrical speeimens, the gemmation is identical, and, if the eentral portion of Pl. XX, fig. 1, be taken only, there would be no distinguishing it from Pl. XX, fig. 5, or the eentral part of Pl. XVII, fig. 1. Lastly, we have before us the beautiful specimen, Pl. XVIII, fig. 1. If Pl. XX, fig. 1, be admitted to be conspecifie with Pl. XVII, fig. 1, there is nothing to prevent Pl. XX, figs. 4 and 6, being so also.

I am in doubt as to the identity of Pl. XXII, fig. 1. The internal structure is that of this speeies, but the three very prominent bourrelet calice margins would imply that the original calicine dise gave off but a single bud at a time, each bud repeating the process in a similar manner to some individuals of *T. wellingtonensis*.

Lindström's illustration of his *Amplexus appendiculatus* of the Upper Silurian rocks of China would imply a elose relationship with the present speeies.

Localities.—Borce Creek, Portions 2, 3, $12\frac{44}{1}$, Parish Cudal, County Ashburnham: Mandagery Creek, Portion 102, Parish Bell, County Ashburnham: Portions 84 and 92, Parish Culrindi, County Darling: Boundary, Portion 77, Parish Eurimbula, County Gordon: Portion 29, Parish Narragal, Molong Distriet, County Gordon: east side of Portion 5, Parish Mumbil, County Wellington: Portion 98, Parish Gamboola, County Wellington: Portion 81, Parish Larras Lake, County Wellington: Jier's Farm, Ponto Road, eight miles from Wellington, County Lincoln: Portion 157, Parish Burdekin, County Inglis (*C. Cullen*—Mining and Geological Museum).

TRYPLASMÆ, *sps.*

Observations.—Specifically indeterminable corals have been met with at the following localities :—

1. Boree Creek, Portion $12\frac{44}{1}$, Parish Cudal, County Ashburnham (*C. Cullen*).
2. Boree Creek, Portion 3, Parish Cudal, County Ashburnham (*C. Cullen*).
3. Portion 39, Parish Narragal, County Gordon (*C. Cullen*).
4. Portion 13, Parish Eurimbula, County Gordon (*C. Cullen*).
5. Catambal Range, south of Wellington, County Gordon.
6. East side of Portion 5, Parish Mumbil, County Wellington (*C. Cullen*).
7. Portion 53, Parish Crawney, County Brisbane (*C. Cullen*).
8. Portion 51, Parish Turon, County Roxburgh (*M. Morrison*).
9. Mt. Gray Mine, Mt. Gray, eight miles south-south-east of Trunkey, County Georgiana (*T. A. Smith*).

PLATES AND EXPLANATIONS.

Plates X–XX were prepared and reproduced by Mr. A. E. Dyer, and Plates XXI–XXVIII were drawn by Mr. F. R. Leggatt, and lithographed by Mr. E. W. Minchen, at the Government Printing Office, Sydney, under the direction of Mr. W. A. Gullick, Government Printer.

PLATE X.

Tryplasma Lonsdalei, *Eth. fil.*

Fig. 1. Large convex block seen from the base.

Fig. 2. Mass of weathered corallites.
a. Fistulæ.

Fig. 3. Another series of corallites, less weathered than in Fig. 2.
a. Double gemmation.

a
a
a
3
2
1

PLATE XI.

Tryplasma vermiformis, *Eth. fil.*

Fig. 1. Block of limestone, with corallites lying in various directions.
- *a.* Double gemmation.
- *b.* Corallite with epitheca.
- *c.* Treble gemmation.
- *d.* „ „

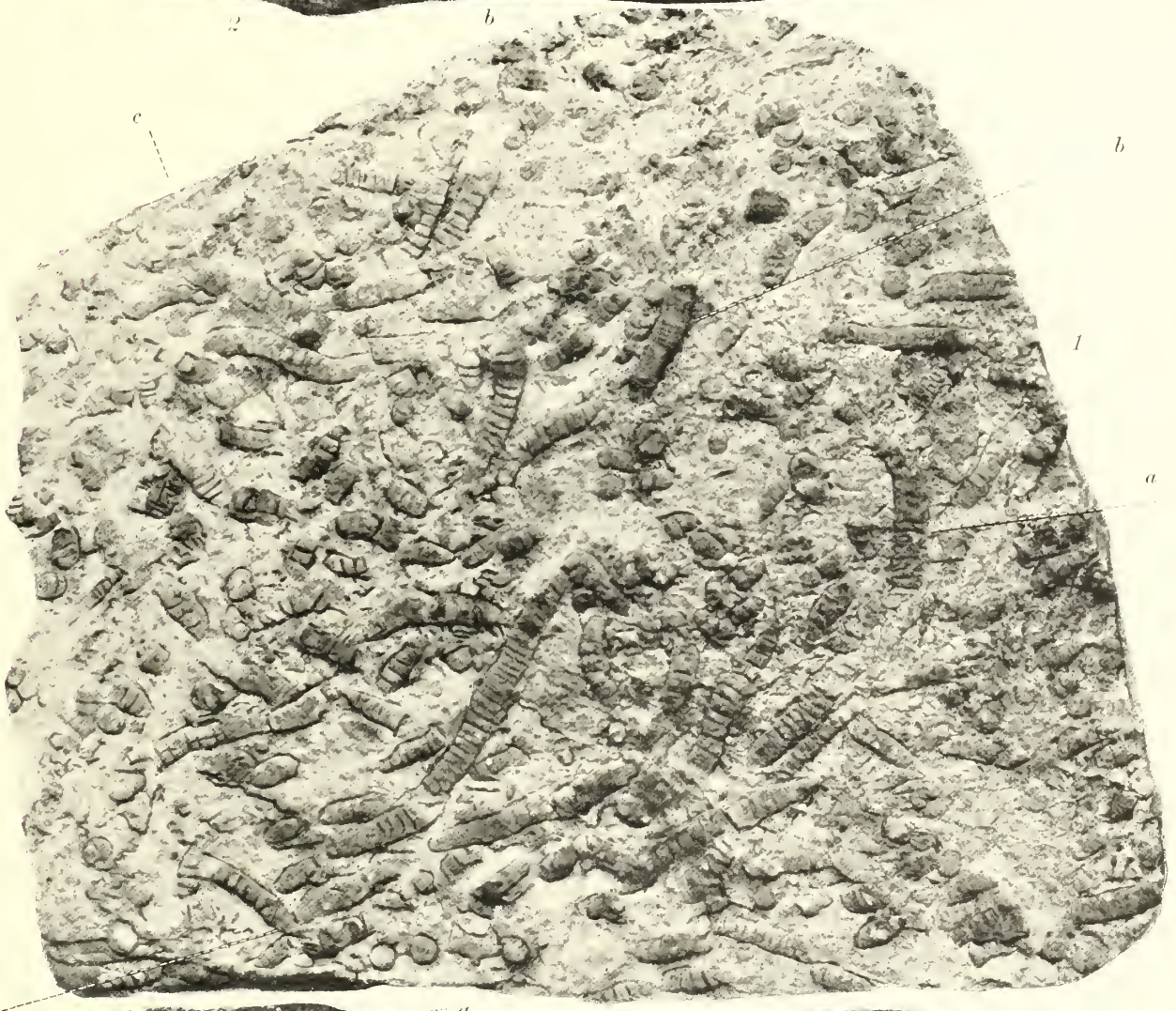
Tryplasma Lonsdalei, *Eth. fil.*

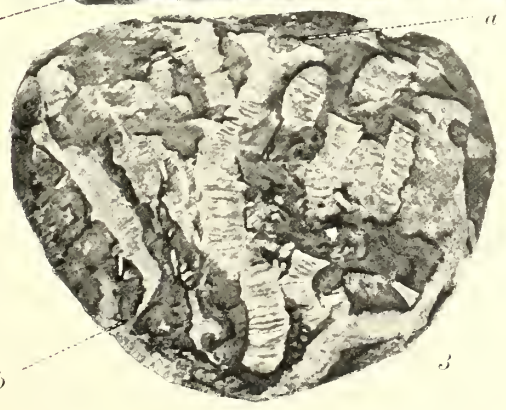
Fig. 2. Portion of a highly-weathered corallum.
- *a.* Double gemmation.
- *b.* Fistulæ.

Fig. 3. Another similar but smaller specimen.
- *a.* Double gemmation.
- *b.* Fistulæ.

Fig 4. Portion of a corallum seen in naturally-weathered transverse section.
- *a.* Fistula.

a
a
a
2
b


c
b
1
a
d


a
b
3

a
4

PLATE XII.

Tryplasma Lonsdalei, *Eth. fil.*

Fig. 1. Small weathered block, with a fine example of double gemmation (*a*).

Tryplasma Lonsdalei, *var.* scalariformis, *Eth. fil.*

Fig. 2. Weathered surface of block, with scattered corallites.

a. Double gemmation.

b. Treble gemmation.

Fig. 3. Scattered corallites on weathered limestone surface, displaying the regular, step like tabulæ, which are equally well seen in Fig. 2.

3

1

2

PLATE XIII.

Tryplasma congregationis, *Eth. fil.*

Fig. 1. Numerous sub-parallel corallites on weathered surface of a limestone block. On the right hand side are finely displayed the tiers of fistulæ, and generally the regular tabulæ; at the bottom of the block is an instance of double gemmation.

Tryplasma, sp.

Fig. 2. Two very long corallites of an undetermined species.

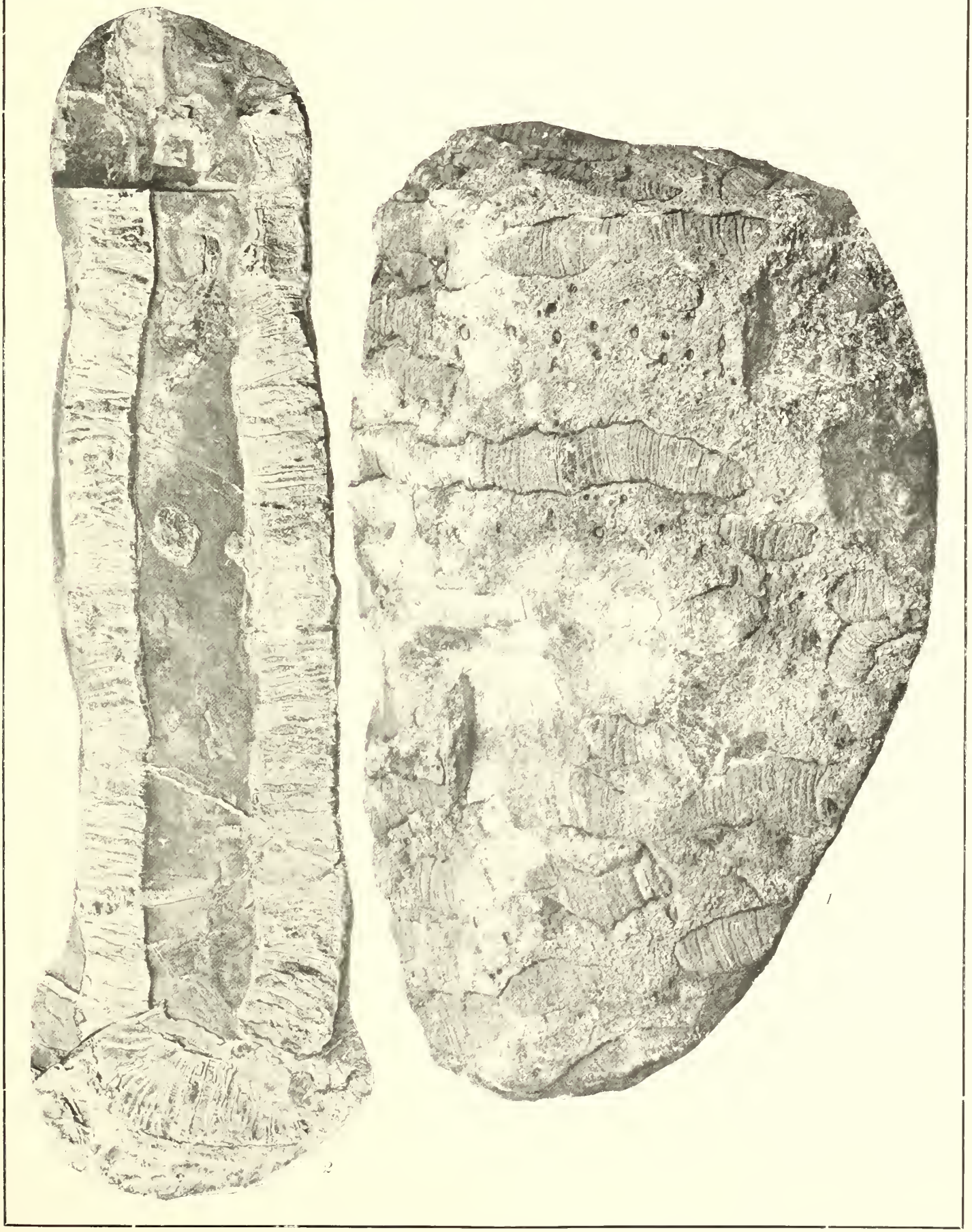


PLATE XIV.

Tryplasma dendroidea, *Eth. fil.*

Fig. 1. Group of young corallites.

Tryplasma liliiformis, *Eth. fil.*

Fig 2. Weathered longitudinal sections of several corallites.

a. Bud.

b. Expanding calice.

Fig. 3. Weathered matrix surface showing a characteristic corallite, and numerous scattered radiciform processes (*a*).

Tryplasma Lonsdalei, *var.* scalariformis, *Eth.*

Fig. 4. Weathered longitudinal sections of numerous corallites.

a. Treble buds.

a
a
a
4
a
a
a
3
b
a
2
1

PLATE XV.

Tryplasma princeps, *Eth. fil.*

Fig. 1. Portion of a highly-weathered large cylindrical corallite, showing the vertical grooves left by the removal of the septal lamellæ, and holes by that of the septal spines.

Tryplasma liliiformis, *Eth. fil.*

Fig. 2. A typical corallite with bell-mouthed calyx, seen in natural longitudinal section.

Fig. 3. Two corallites generally similar to Fig. 2, springing from the same parent corallite below.

Fig. 4. Natural longitudinal section of a corallite, with unusually thick walls.

Tryplasma dendroidea, *Eth. fil.*

Fig. 5. Three young corallites, which, even at this stage, show indications of widening calices.

Tryplasma columnaris, *Eth. fil.*

Fig 6. Weathered corallite, displaying grooves left by the septal lamellæ, and holes by the septal spines; the edges of the tabulæ are also seen.

Tryplasma dendroidea, *Eth. fil.*

Fig. 7. A typical corallite four inches long.

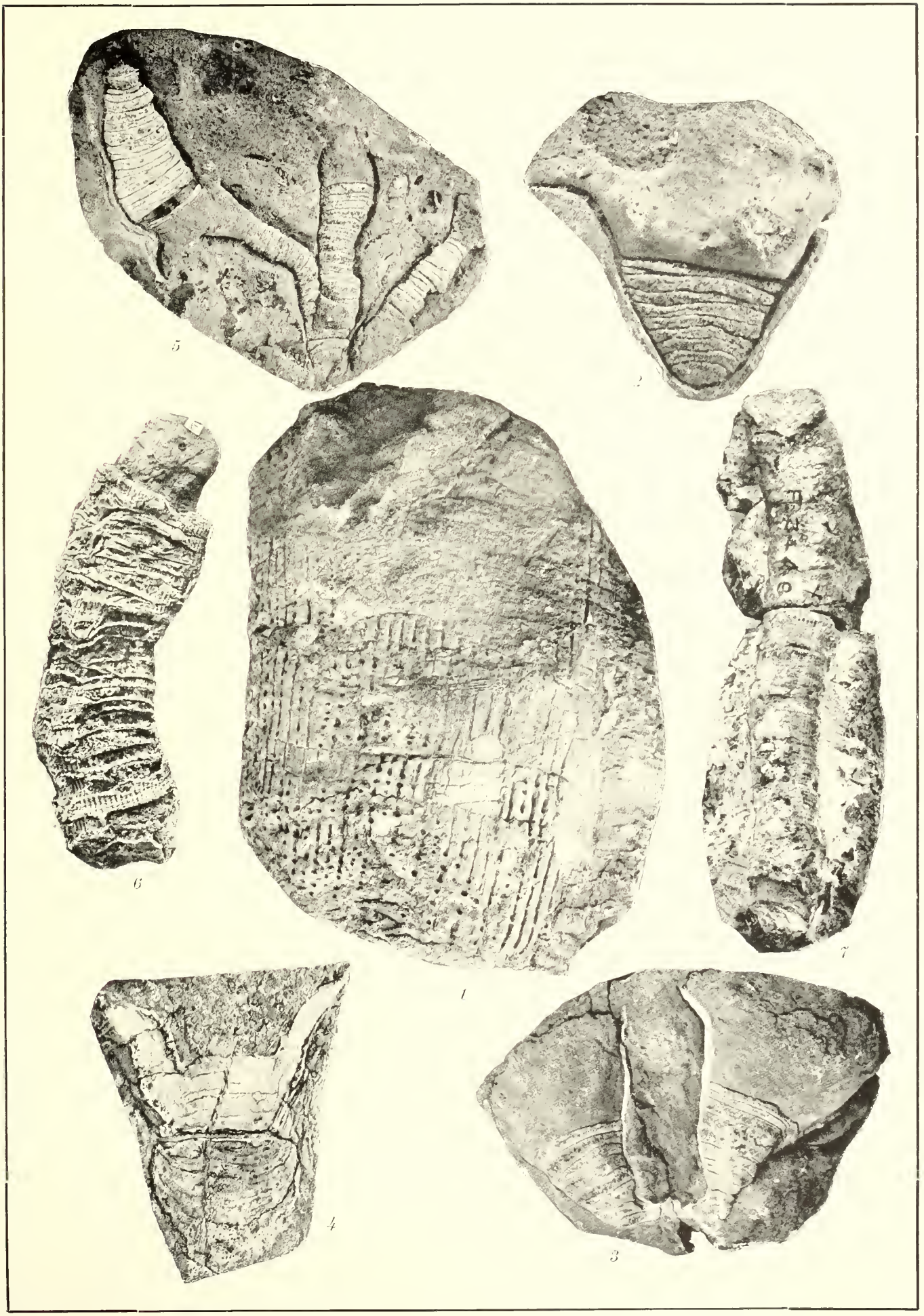


PLATE XVI.

Tryplasma, sp.

Fig. 1. Polished limestone surface, with turbinate and curved corallites exhibiting copious budding. The regular tabulæ are seen in all the corallites, varying in their degree of distance apart; the central right hand corallite displays an expanding calice.

Fig. 2. Transverse view of the same specimen. Partial union of the corallites is visible, and well-marked fistulæ (*a*).

Tryplasma Lonsdalei, *var.* minor, *Eth. fil.*

Fig. 3. Transverse view of the small corallites of this species.

Fig. 4. Longitudinal view of the same.

Tryplasma wellingtonensis, *Eth. fil.*

Fig. 5. Here are seen at least two, and perhaps three, corallites, surmounted one above the other.

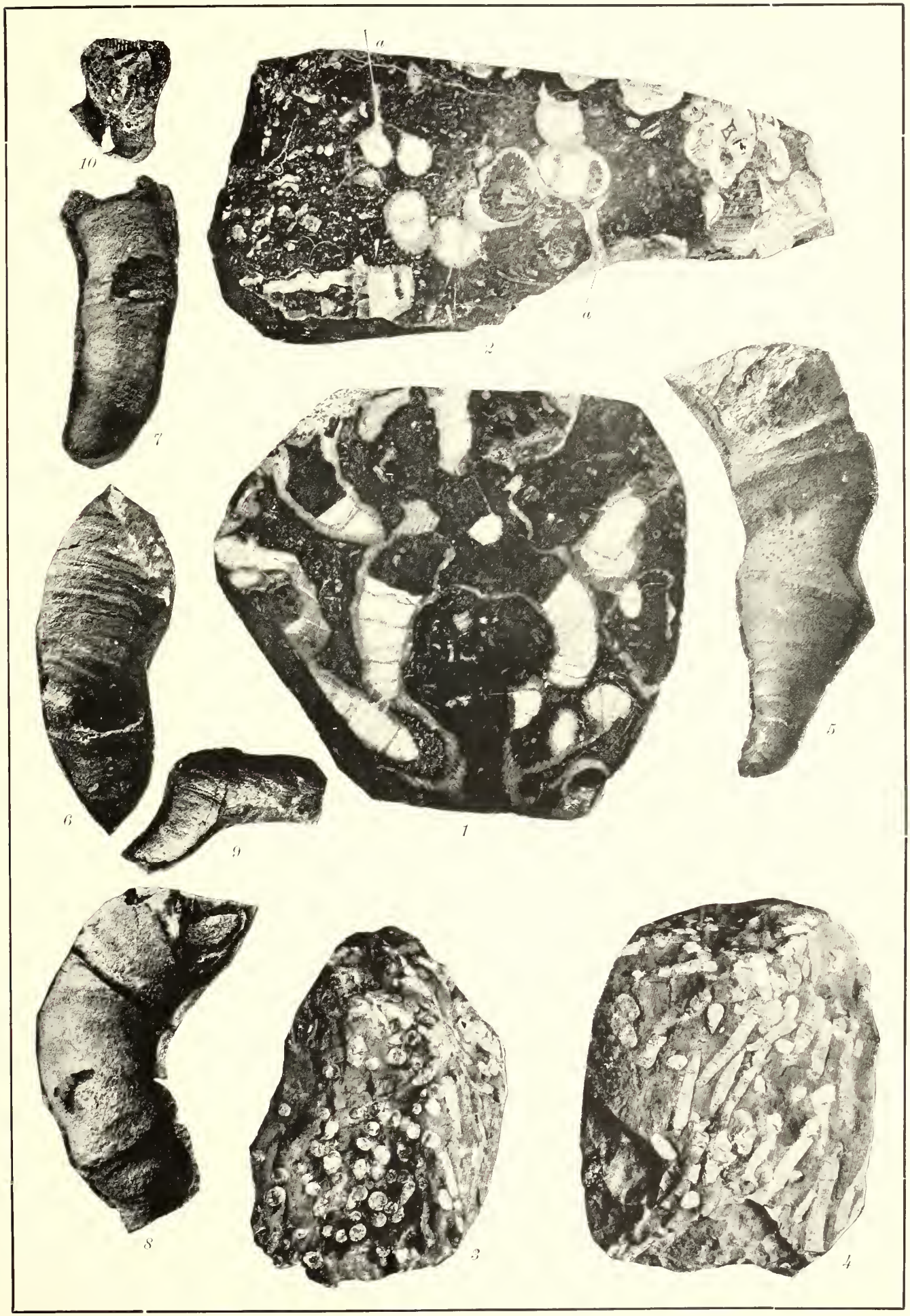
Fig. 6. Two corallites, the younger and larger springing from the calice margin of the parent.

Fig. 7. A more or less turbinate corallite.

Fig. 8. A curved corallite, with contracted peduncle-like base.

Fig. 9. A small corallite, bent at a right angle.

Fig. 10. The calice of Fig. 9.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4

PLATE XVII.

Tryplasma princeps, *Eth. fil.*

Fig. 1. The largest single corallite known, with above a bud (*a*), which at first sight would appear to be wholly parietal, but in reality is half parietal, half calicular.

a. Bud.

b. Radiciform basal processes.

c. Radiciform process, or fistula (?).

Fig. 2. Base of a similar corallite to Fig. 1, with radiciform processes (*a*), lateral view.

Fig. 3. Base of a smaller cylindrical corallite, with radiciform processes (*a*).

Fig. 4. Polished section of a large calice, exhibiting septal lamellæ and spines.

Fig. 5. Polished section of a small corallite taken near the base, distinctly showing septal spines of two orders.

Fig 6. Naturally-weathered longitudinal section of a curved corallite, exhibiting very incomplete, and at times distant tabulæ, doubtfully referred to this species.

Tryplasma liliiformis, *Eth. fil.*

Fig. 7. Small corallite rapidly expanding to form the large calice, with calicular bud above (*a*).

Fig. 8. A similar corallite without a bud, but with distinct rugæ.

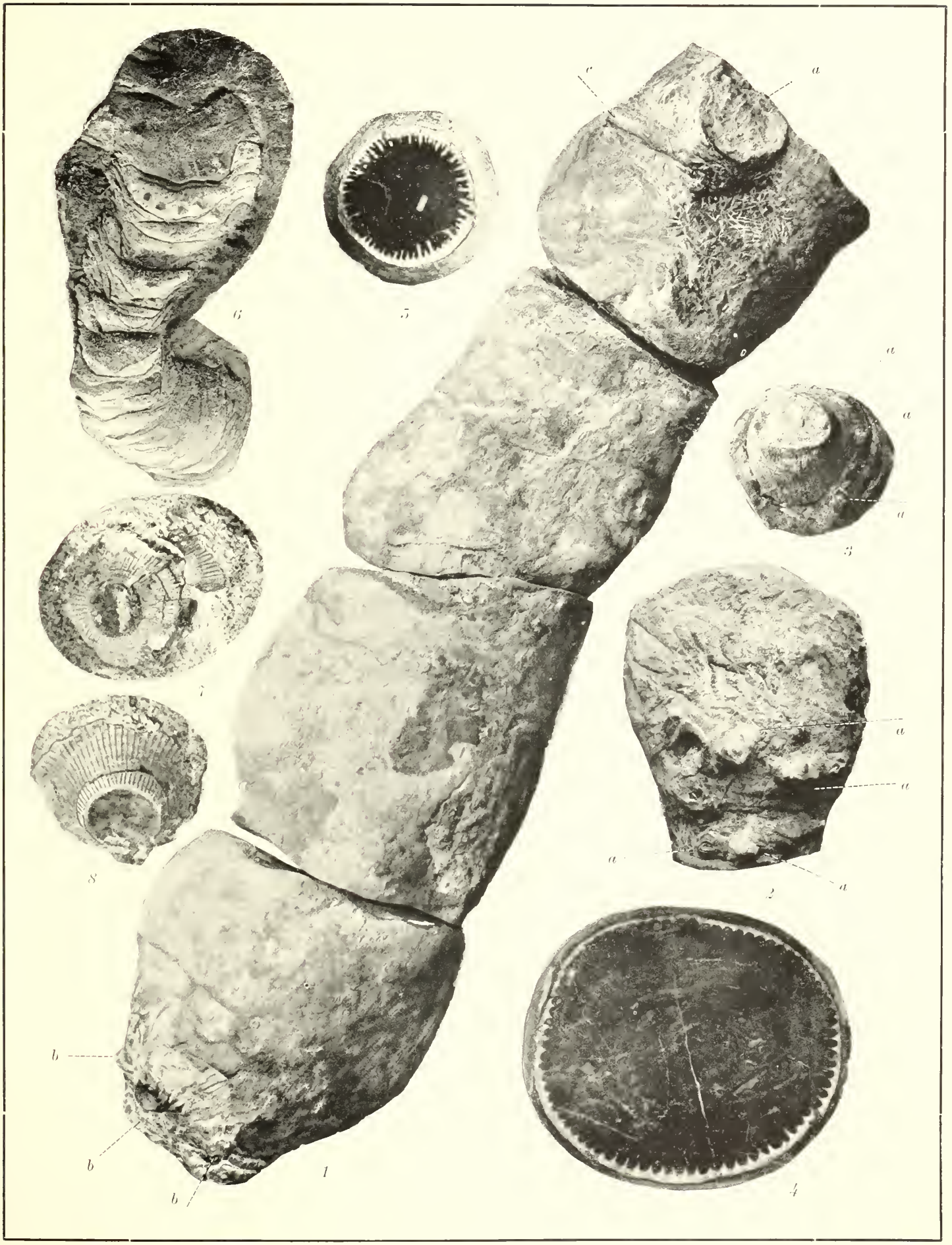
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PLATE XVIII.

Tryplasma princeps, *Eth. fil.*

Fig. 1. A very fine example of calicinal budding. Below are three obconical or cylindro-conical corallites united by their walls; the larger gives off a number of younger cylindro-conical individuals, of which four are here visible.

Tryplasma dendroidea, *Eth. fil.*

Fig. 2. A parent corallite, and an example of double gemmation.

Fig. 3. Another specimen similar to Fig. 2. At the top of the right-hand corallite the septal lamellæ are visible; tabulæ are also seen throughout.

Fig. 4. An instance of triple gemmation; the finely-lined epitheca is visible by the aid of a magnifying glass.

Fig. 5. Longitudinal, weathered section of a corallite, below giving rise to three buds; above, another corallite with two buds, the former appearing to have organic attachment to the lower group.

Fig. 6. Longitudinal weathered section of a corallite below, giving rise to three buds, one very much younger than the other two.

Tryplasma princeps, *Eth. fil.*

Fig. 7. A young corallite.

4
2
7
6
1
3
5

PLATE XIX.

Tryplasma princeps, *Eth. fil.*

Fig. 1. Transverse view of the basal half of Pl. XVIII, Fig. 1, the largest corallite displaying seven calicinal rejuvenescent corallite buds.

Fig. 2. Transverse view of the lower fractured surface of the upper half of Pl. XVIII, Fig. 1, with thirteen young corallite, of which eleven are visible.

a. Fistulæ.

Fig. 3. The upper surface of Fig. 2, with twelve corallites, the thirteenth having been crowded out.

Tryplasma Lonsdalei, *Eth. fil.*

Fig. 4. Small group of corallites seen in transverse fractured section.

Tryplasma columnaris, *Eth. fil.*

Fig. 5. Portion of a corallite, partly decorticated, showing the septal spine holes.

Tryplasma dendroidea, *Eth. fil.*

Fig. 6. A small individual, showing triple gemmation.

1

4

5

6

3

2

a

PLATE XX.

Tryplasma princeps, *Eth. fil.*

Fig. 1. Cylindro-obconical corallite, with radiciform basal processes (*a*).

Fig. 2. Natural longitudinal section of a similar specimen, with crowded tabulæ.

Fig. 3. Calice of a cylindrical example, with six rejuvenescent buds.

Fig. 4. A much decorticated, slightly curved coral, with thirteen calicino-marginal rejuvenescent buds.

Fig. 5. Calice similar to Fig. 3, with six rejuvenescent buds.

Fig. 6. Another example, in which there are five small calicino-marginal buds.

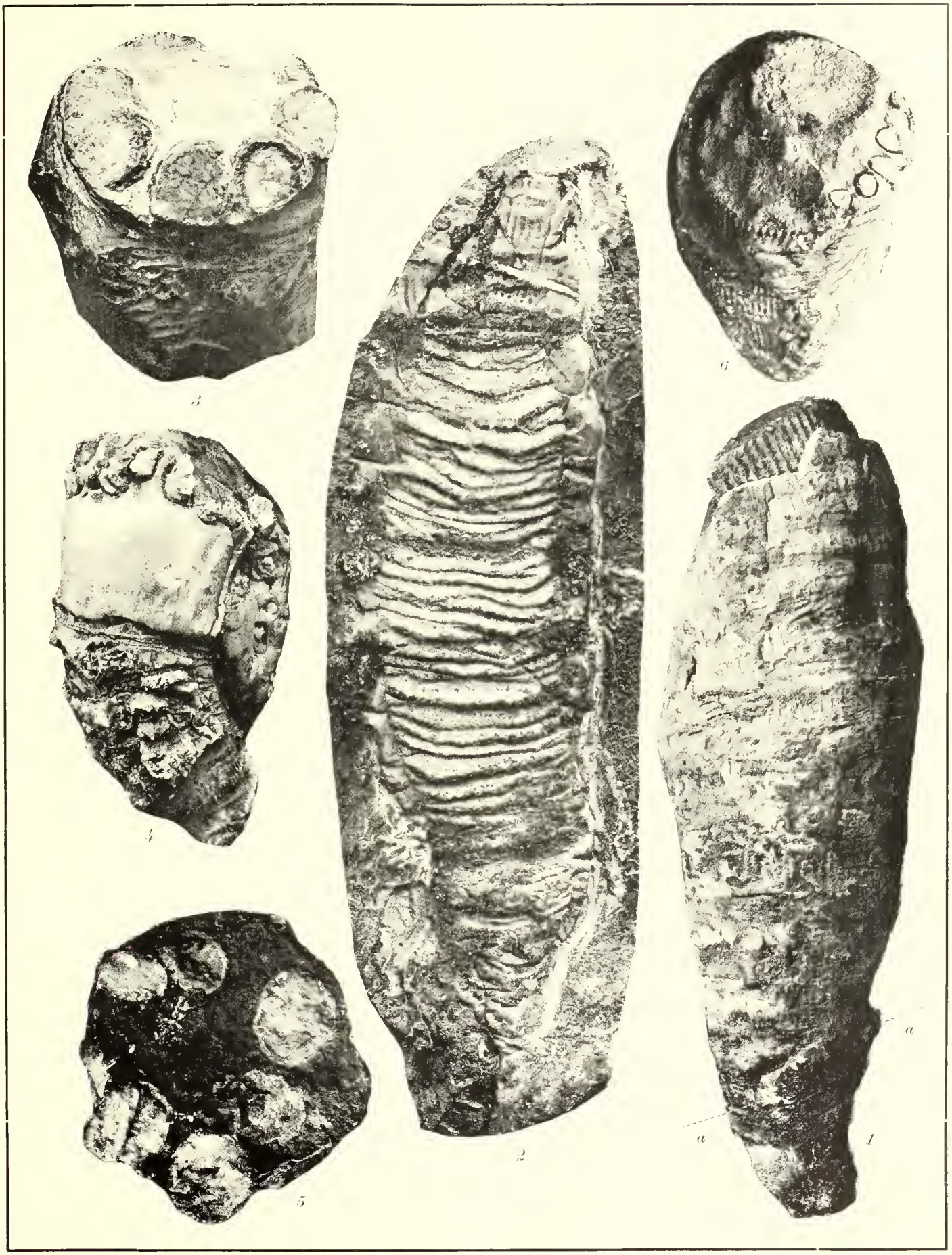
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PLATE XXI.

Tryplasma princeps, *Eth. fil.*

Fig. 1. Decorticated obconical corallite, with pitted grooves representing the septal lamellæ and spines, the longitudinal ridges indicating the rugæ.

Fig. 2. A portion of the surface towards the base of the same corallite (Fig. 1) more highly magnified.

Fig. 3. A portion of a longitudinal section of a corallite, prepared for the microscope, showing the bases of the septal lamellæ, and the tabulæ.

Fig. 4. The lower left-hand corner of Fig. 3 highly magnified, displaying the primordial septal lamellæ.

Fig. 5. Transverse section of a corallite, prepared for the microscope, with the thick peripheral septal zone, septal spines, and cut edges of tabulæ.

Fig. 6. A small portion of the septal zone, highly magnified.

Fig. 7. Longitudinal section, prepared for the microscope, showing caliee, septal spines, and tabulæ.

Fig. 8. Transverse section of a smaller corallite, prepared for the microscope, exhibiting the septal spines and cut edges of tabulæ.

Fig. 9. A few of the septal spines, highly magnified.

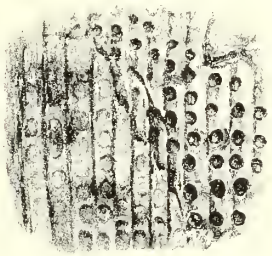
Tryplasma congregationis, *Eth fil.*

Fig. 10. Portions of three corallites in longitudinal section, prepared for the microscope, exhibiting, regular complete tabulæ; one of the corallites sends forth two fistulæ, and two others are seen in transverse section in the matrix.

Tryplasma wellingtonensis, *Eth fil.*

Fig. 11. Transverse section of portion of a corallite, prepared for the microscope, showing the septal spines and vesicular tabulæ.

Fig. 12. A portion of Fig. 11 highly magnified.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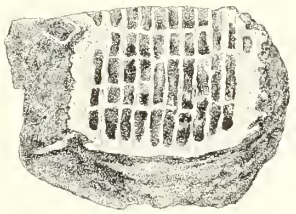
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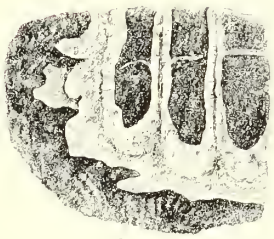
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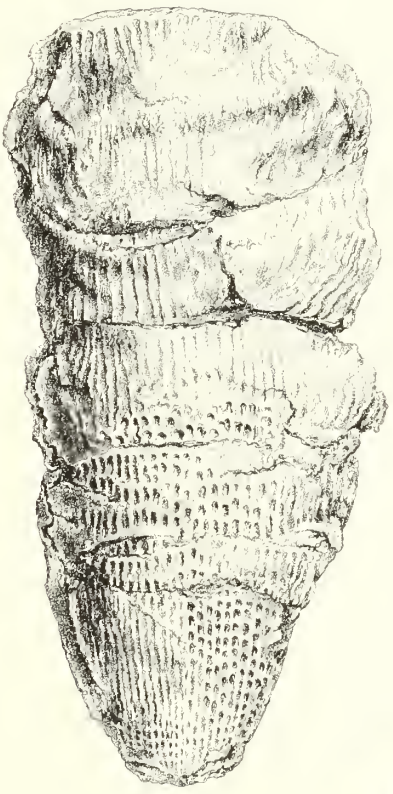
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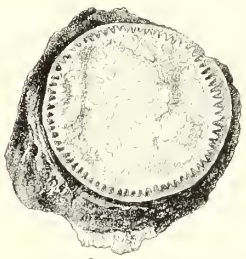
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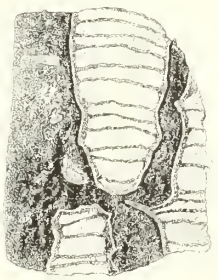
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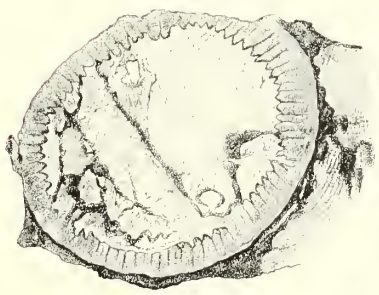
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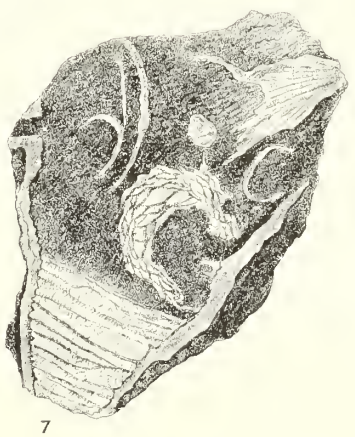
7

PLATE XXII.

Tryplasma princeps, *Eth fil.* (?)

Fig. 1. A large corallite, with strong bourrelets or accretion rings, in which it departs widely from this species.

Tryplasma wellingtonensis, *Eth. fil.*

Fig. 2. A turbinate corallite, with a portion of the wall removed, showing the septal lamellæ grooves and holes left by the septal spines.

Fig. 3. A small calice, displaying the primary septal spines and secondary granules, tabulæ, and radiciform processes.

Fig. 4. Some of the septal spines and granules from Fig. 3 enlarged.

Tryplasma derrengullenensis, *Eth. fil.*

Fig. 5. A small turbinate corallite, with bases of radiciform processes.

Fig. 6. A more obconical corallite, showing the remains of the calice with the grooves left by the primary and secondary septal lamellæ, and the holes by the septal spines of the two orders.

Fig. 7. A number of the septal grooves and spine holes highly magnified.

Fig. 8. A more or less distorted corallum, turbinate below, cylindrical above, with bases of radiciform processes.

Tryplasma delicatula, *Eth fil.*

Fig. 9. Transverse section of two corallites prepared for the microscope.—x 3.

Tryplasma princeps, *Eth. fil.*

Fig. 10. Transverse section of a radiciform process prepared for the microscope.—x 3.

Tryplasma dendroidea, *Eth. fil.*

Fig. 11. Parent corallite and four buds.

Fig. 12. ,, and three buds.

Fig. 13. Polished longitudinal section of part of a corallite, showing regular complete tabulæ.

Fig. 14. Transverse section of a corallite, prepared for the microscope, with sharp acicular septa spines, and wide central tabulate area.—x 2.

Fig. 15. Transverse view of a naturally-fractured corallite, displaying a tabulum with circumferential septal nicks.

Tryplasma, sp.

Fig. 16. Transverse section prepared for the microscope of a corallite of the coral represented in Pl. XVI, Figs. 1 and 2, showing the thickened wall and septal teeth.—x 2.

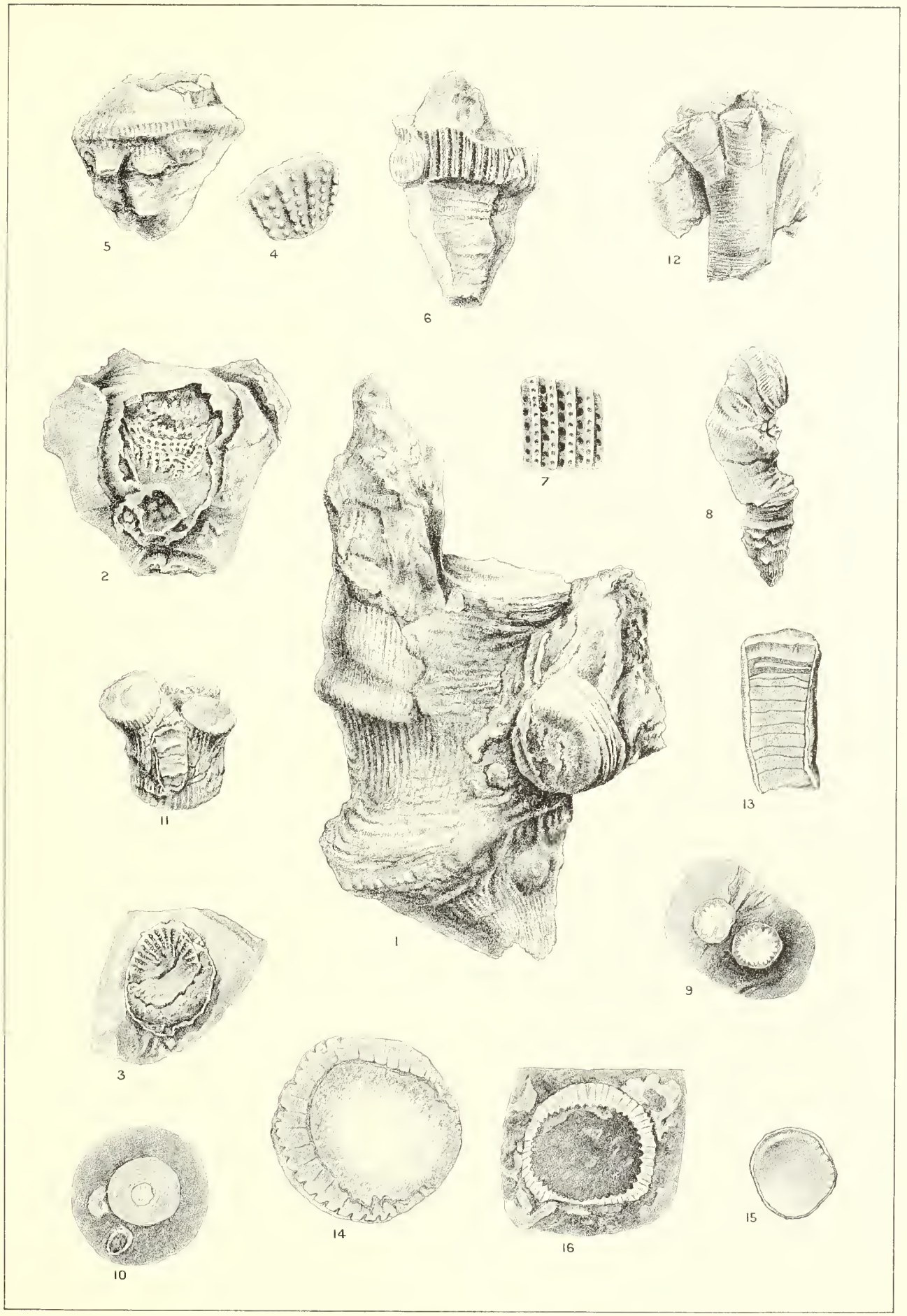
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PLATE XXIII.

Tryplasma princeps, *Eth. fil.*

Fig. 1. A longitudinal section, prepared for the microscope, of a large cylindrical corallite, showing the thickened wall and broken-up tabulæ.

Fig. 2. A similar section of part of another cylindrical corallite, exhibiting the thickened wall, and septal spines; the tabulæ are less broken up, some complete, others forming lenticular vesicles.

Fig. 3. A portion of the wall of Fig. 2, showing the septal spines.

Tryplasma vermiformis, *Eth fil.*

Fig. 4. Longitudinal section of a corallite, prepared for the microscope, showing the distant, complete, and horizontal tabulæ; in one of the latter is a peculiar medium dip.—x $2\frac{1}{2}$.

Fig. 5. Transverse sections of four corallites, prepared for the microscope; one of these shows a very beautiful example of compound calicular rejuvenescent budding.

Tryplasma delicatula, *Eth. fil.*

Fig. 6. Longitudinal section of several corallites, with fistulæ and tabular spines.—x 2.

Fig. 7. A small portion of one of the corallites highly enlarged.

Tryplasma, sp.

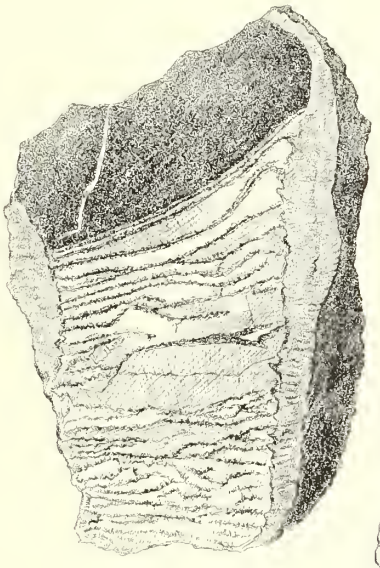
Fig. 8. Longitudinal section, prepared for the microscope, of portions of two corallites of the coral represented in Pl. XVI, Figs. 1 and 2, showing the septal spines and complete tabulæ.—x 2.

Tryplasma dendroidea, *Eth. fil.*

Fig. 9. Transverse section of a corallite, prepared for the microscope, showing delicate short-acicular septal spines, and the wide tabulate area.—x 2.

Tryplasma congregationis, *Eth. fil.*

Fig. 10. Transverse section of one and a half corallites, prepared for the microscope, with similar septal spines to those in Fig. 9. In the right-hand half-corallite is a portion of a rejuvenescent bud (?).



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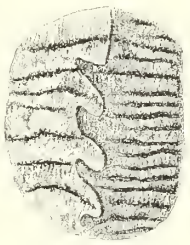

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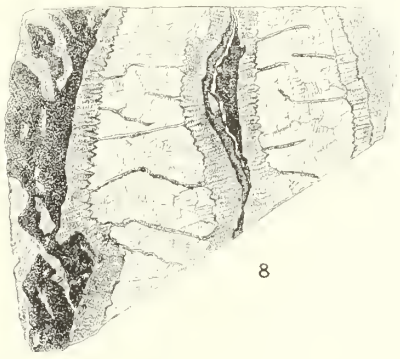

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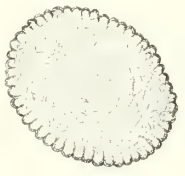

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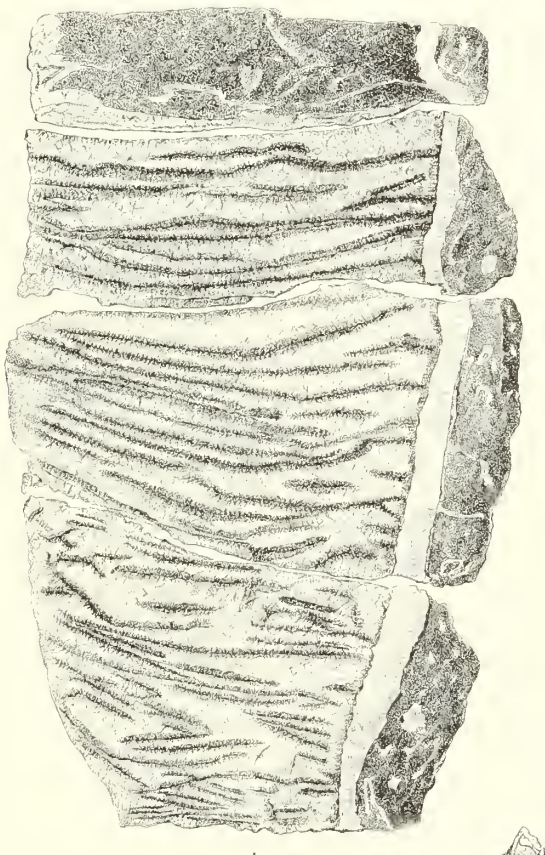

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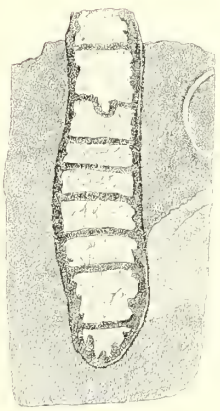

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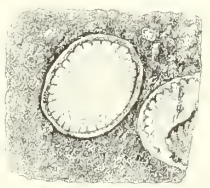

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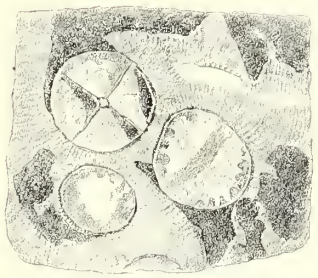

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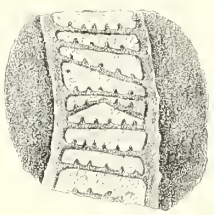

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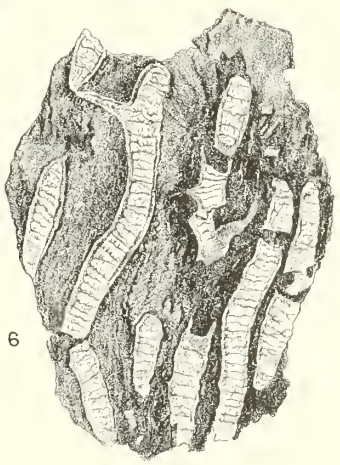

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PLATE XXIV.

Tryplasma liliiformis, *Eth. fil.*

Fig 1. Portion of a corallite in longitudinal section, prepared for the microscope, exhibiting a portion of the calice and tabulæ below. –x 2.

Tryplasma columnaris, *Eth. fil.*

Fig. 2. Longitudinal section of portion of a corallite, prepared for the microscope, displaying the thick solid walls, septal spines, complete and incomplete tabulæ and spines thereon.—x 2.

Fig. 3. Similar transverse section, exhibiting the cut edges of vesicular tabulæ, and the cut ends of the vertical spines.—x 2.

Fig. 4. A few of the cut ends (Fig. 3) of the tabular spines more highly magnified.

Fig. 5. Another transverse section of a corallite prepared for the microscope. Here the wall is very much thickened, and the primary septal spines greatly elongated; the vertical spines are again visible.—x 2.

Tryplasma dendroidea, *Eth. fil.*

Fig. 6. Longitudinal section of a small portion of a corallite, prepared for the microscope, exhibiting characteristic tabulæ.—x 2.

Tryplasma Lonsdalei, *var.* scalariformis, *Eth. fil.*

Fig. 7. Transverse sections of two corallites, prepared for the microscope; the upper shows a rare feature in this species—the cut edge of an incomplete tabulum.—x 2.

Fig. 8. Similar longitudinal section, exhibiting the regular step-like tabulæ.—x 2.

Fig. 8*a*. Transverse section of a corallite, displaying the parent corallite and three rejuvenescent buds.—x 2.

Tryplasma Lonsdalei, *var.* minor, *Eth. fil.*

Fig 9. Longitudinal section of portions of two corallites, prepared for the microscope, showing septal spines and tabulæ.—x 2.

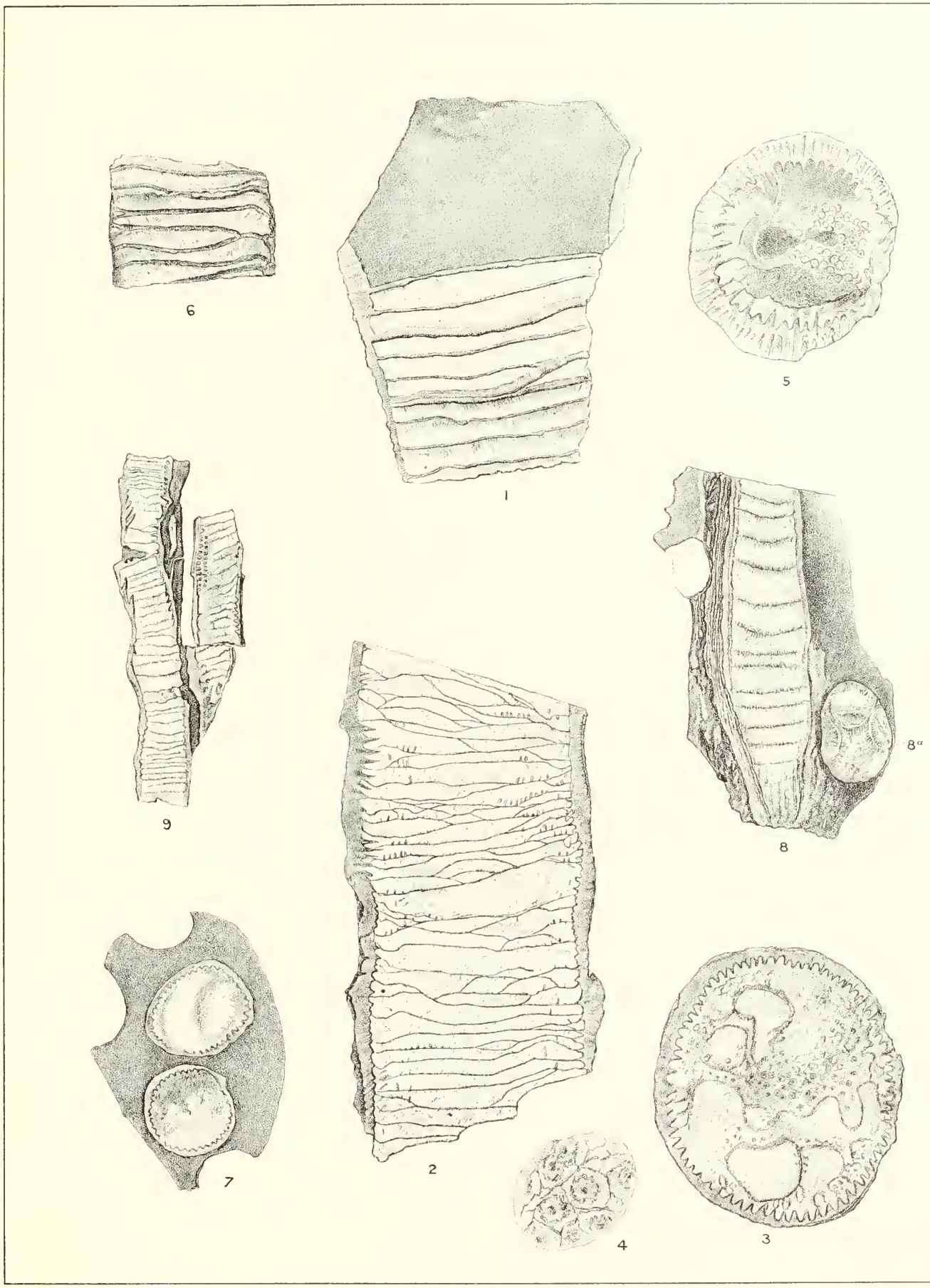
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PLATE XXV.

Tryplasma Lonsdalei, *var.* scalariformis, *Eth. fil.*

Fig. 1. Section of a piece of limestone, prepared for the microscope, with corallites both in transverse and longitudinal section.—x 2.

Fig. 2. Longitudinal section of part of a corallite, showing incomplete fistulæ.—x 2.

Fig. 3. A similar section of another corallite, with a fistula cut across, and again enclosed in a second wall.—x 2.

Fig. 4. Transverse section of a corallite, prepared for the microscope, exhibiting long septal spines, and the cut edge of a tabula.—x 2.

Tryplasma Lonsdalei, *Eth. fil.*

Fig. 5. Longitudinal sections of portions of two corallites, prepared for the microscope, showing oblique, curved, or rolling tabulæ and septal spines.—x 2.

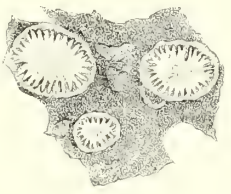
Tryplasma Lonsdalei, *var.* minor, *Eth. fil.*

Fig. 6. Transverse sections of three corallites, prepared for the microscope, showing the relatively strong septal spines in this variety.—x 2.

Fig. 7. Similar longitudinal sections, one of the corallites displaying incipient fistulæ.—x 2.

Tryplasma liliiformis, *Eth. fil.*

Fig 8. Longitudinal section of portion of a corallite, prepared for the microscope, showing complete and incomplete tabulæ.—x 2.



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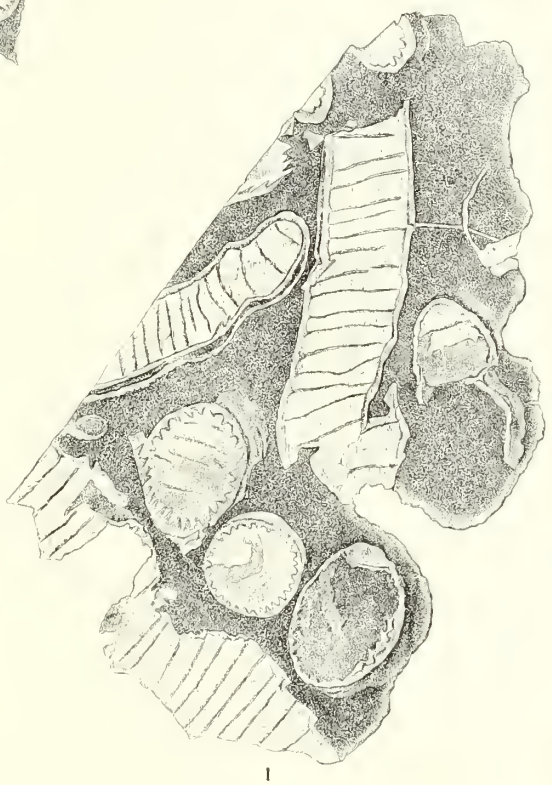

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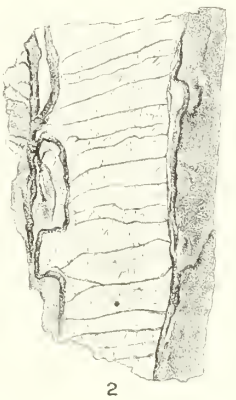

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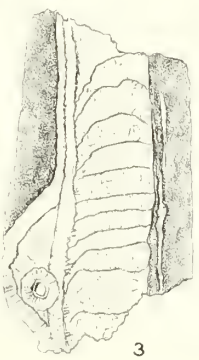

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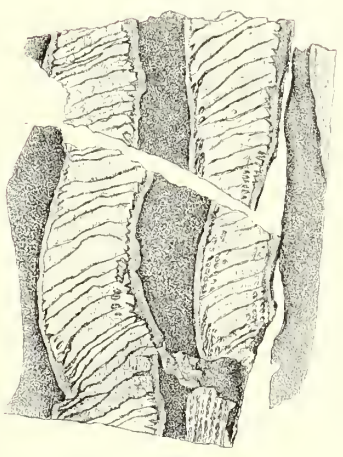

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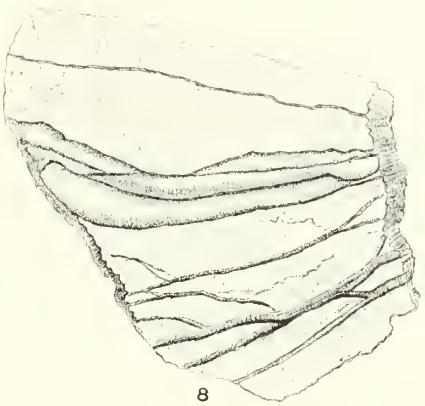

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PLATE XXVI.

Tryplasma Lonsdalei. *Eth. fil.*

Fig. 1. Transverse sections of three corallites, prepared for the microscope.—x 2.

Fig. 2. Similar section of another corallite cut obliquely with three tabulæ, one with a central dip.—x 2.

Fig. 3. Longitudinal section of a corallite, prepared for the microscope, displaying the septal spines and tabulæ, some of the latter in close groups.—x 2.

Fig. 4. A similar section to Fig. 3. The tabulæ are here even more clearly grouped, and many with downwardly bent edges.—x 2.

Fig. 5. Another longitudinal section with septal spines, tabulæ, and fistulæ; the third tabulum from the top of the section has an eccentric depression or dip, similar to that visible in Fig. 2.—x 2.

Fig. 6. Transverse section of a corallite, exhibiting well developed septal spines on the right-hand side, moderately well developed spines on the left, and on the bottom margin a few slight crenulations representing the septal lamellæ.—x 2.

Fig. 7. One of the fistulæ represented in Fig. 5, displaying septal spines at the entrance to the tube, highly magnified.

Tryplasma Lonsdalei, *var.* scalariformis, *Eth. fil.*

Fig. 8. Longitudinal section of a corallite, prepared for the microscope, exhibiting two rejuvenescent buds.—x 2.

Fig. 9. Transverse section, prepared for the microscope, of four rejuveneseent buds, two on the point of separating into distinct corallites.—x 2.

Fig. 10. Similar section of two rejuvenescent corallites and a portion of the parent.—x 2.

Tryplasma Lonsdalei, *var.* minor, *Eth. fil.*

Fig. 11. Portion of a corallum, exhibiting a profuse development of fistulæ.

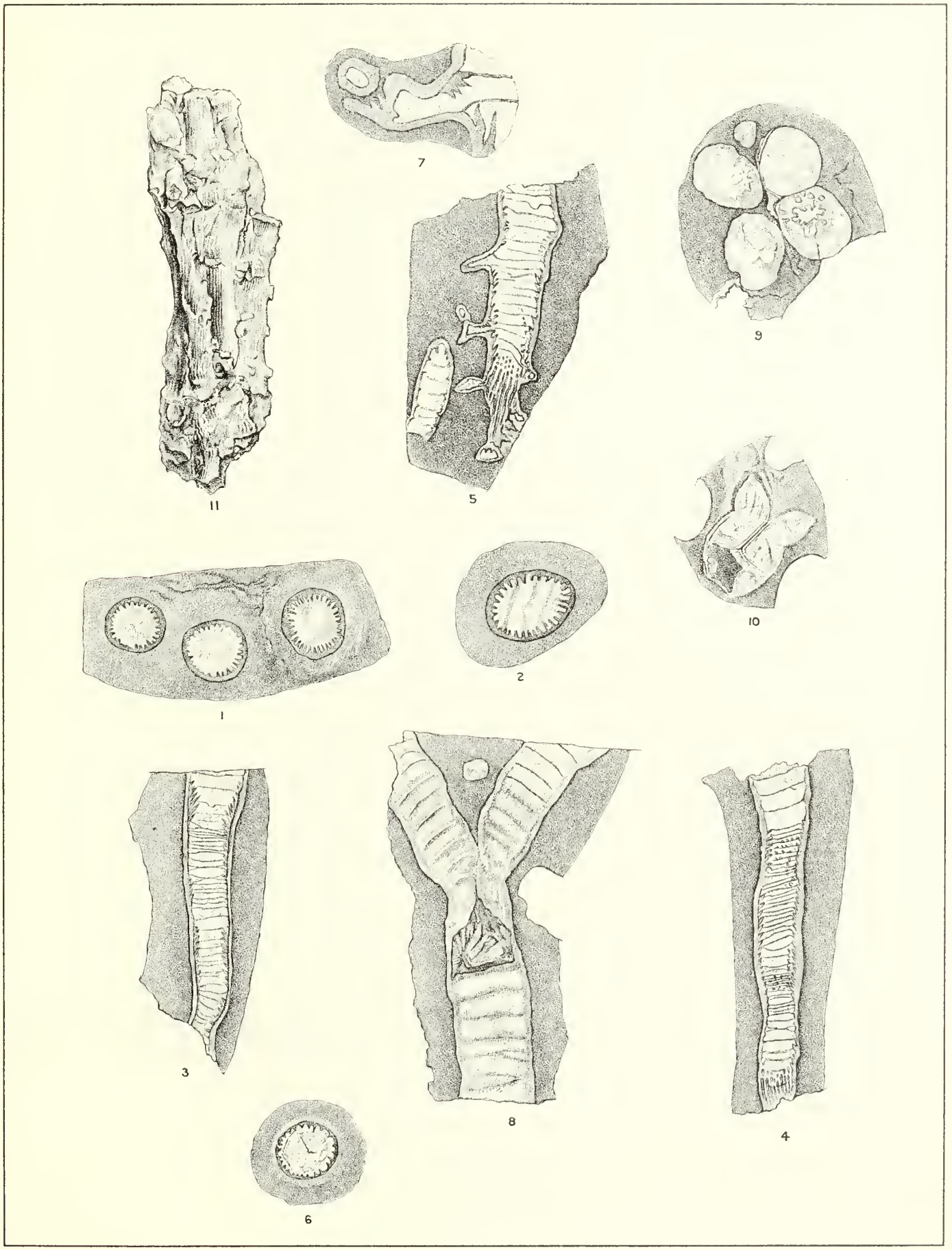
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PLATE XXVII.

Tryplasma liliiformis, *Eth. fil.*

Fig. 1. Weathered surface of matrix, with two corallites, apparently united ; radiciform processes proceed from both.

Fig. 2. Stem portion, with expanding corallite above.

T. dendroidea, *Eth. fil.*

Fig. 3. Two corallites, proceeding from the parent below, highly weathered.

Fig. 4. Very much weathered specimen, with excellent examples of budding.

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PLATE XXVIII.

Tryplasma (?) Murrayi, *Eth. fil.*

Fig. 1. A bunch of corallites, showing the general features of the species.

Fig. 2. Portion of a calice, exhibiting septal spines.

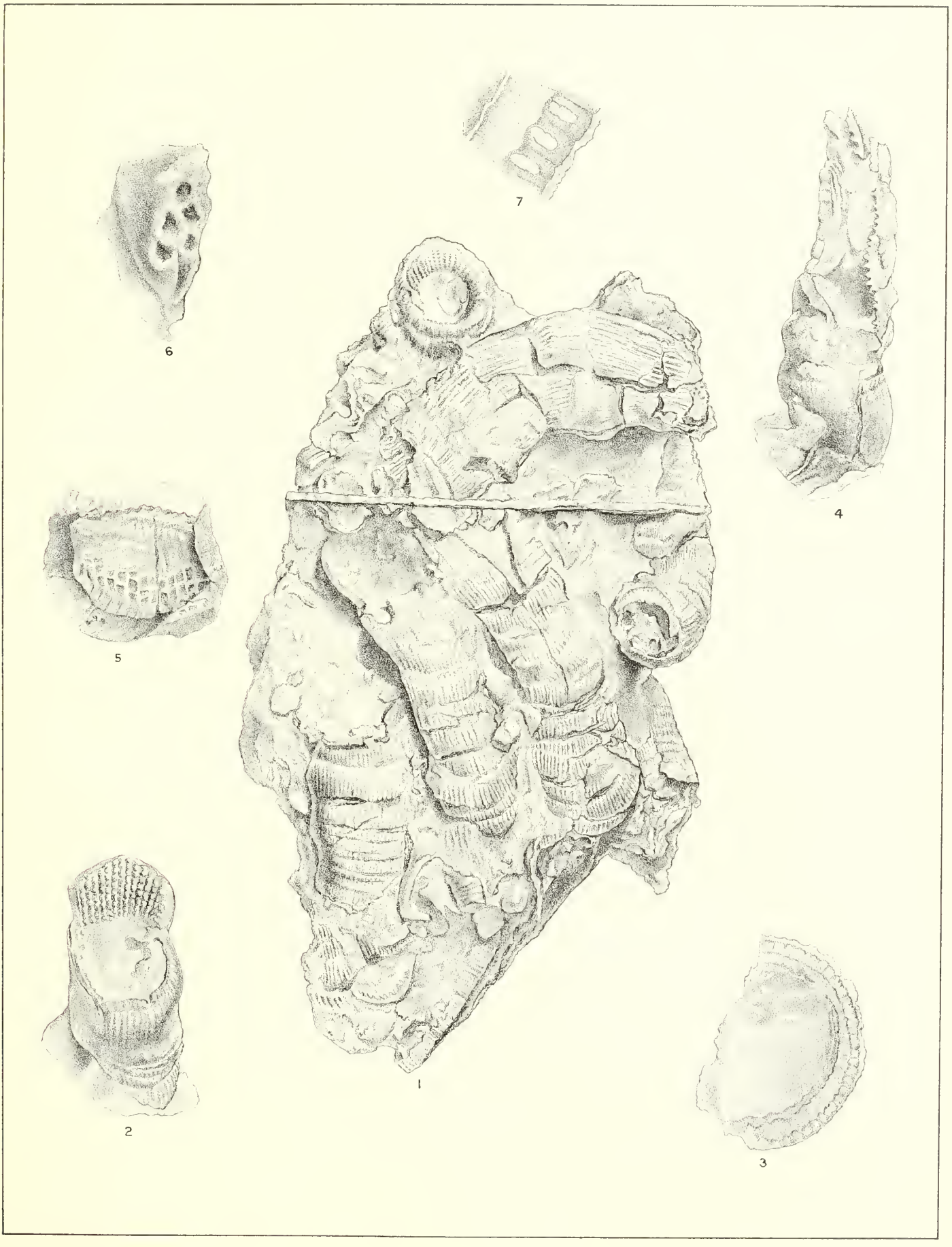
Fig. 3. Transverse section of part of a corallite, prepared for the microscope, displaying septal spines and dissepimental tissue.

Fig. 4. Natural longitudinal section of part of a corallite, showing septal spines on the right-hand side.

Fig. 5. Portion of the weathered surface of a corallite, with dissepimental tissue.

Fig. 6. Natural fractured and weathered oblique section of the peripheral area, with dissepimen tissue.

Fig. 7. A portion of the section represented in Fig. 3, highly magnified.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